WATER MANAGEMENT IN THE SOUTH SASKATCHEWAN RIVER BASIN

REPORT AND RECOMMENDATIONS

ALBERTA
WATER RESOURCES COMMISSION

Prepared by Panel
and Staff
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INTRODUCTION

In 1984, a Panel of the Alberta Water Resources Commission (AWRC) held a series of Hearings to receive the public's views regarding the management of water in the South Saskatchewan River Basin (SSRB). The Hearings followed the first phase of an intensive planning program by Alberta Environment, which began in 1980. The purpose of this program, the South Saskatchewan River Basin Planning Program, is to identify and priorize water use objectives for the basin and to determine the most appropriate strategy for water management to achieve those objectives. The Hearings were established by Order in Council #763/83. This Order appointed the Panel from the AWRC and gave them the responsibility to evaluate the information provided by Alberta Environment's Planning Program and by the public's presentations in order to make recommendations to the Government.

THE SOUTH SASKATCHEWAN RIVER BASIN PLANNING PROGRAM

The waters of the SSRB have played a fundamental role in the social and economic development of southern Alberta. The rivers of the basin are an essential lifeline for much of this arid region. The river valleys, lakes and wetlands support a fragile ecosystem of plants, animals, waterfowl, and fish, all dependent on water for their survival. The rivers have been essential for human settlement, providing water for consumption and waste disposal, agriculture, hydro-electric power, and a myriad of recreational opportunities. Because natural rainfall is low in much of the area, the use of the rivers for irrigation has been an important contribution to the development of a stable and diversified agricultural economy.

Recently, however, water users have come into increasing conflict as they are forced to compete with each other for a limited and highly variable supply of water. The SSRB has the highest consumptive use of water in the province, but receives the least precipitation and has the greatest annual and seasonal variation in supply. In addition, there is a scarcity of wetlands, permanent water bodies and extensive groundwater supplies, which places more strain on the rivers, as they become almost the sole source of water in the basin. Anticipated growth in agricultural production and in population during the next several decades will exacerbate this situation.

To deal with these problems, high priority has been placed on the development of a comprehensive management strategy for water use in southern Alberta. Because it is the policy of the Government to manage water on a river basin basis, and because the flows of the sub-basins of the SSRB are already interconnected through

irrigation return flows, the water resources in the Bow, Oldman and Red Deer Rivers must be managed in concert with each other, rather than individually.

The Government of Alberta is committed to managing water in support of the overall social and economic objectives of the Province. These objectives include the development of a diversified provincial economy, expansion of foreign markets, enhancement of regional growth opportunities, and improvement of the quality of life. Each of these objectives must be carried out without wasting, damaging or polluting provincial resources. Water resource planning is essential to the effective management of the resource and has been an ongoing part of the activity of Alberta Environment, the agency responsible for water resource development, management, and protection in Alberta.

Alberta Environment's Planning Division staff carried out a comprehensive study of the water resources, uses and needs in the SSRB, and of the provincial government programs that relate to water management. They then developed water quantity and quality models and, from them, scenarios to illustrate the effects of various planning options. This first phase of the South Saskatchewan River Basin Planning Program (SSRBPP) is intended to identify the objectives that should guide planning of the basin and to develop a strategy to achieve them. The Public Hearings held by the AWRC Panel are a complement to this process. Subsequently, Alberta Environment will complete the Program, detailing specific ways and means to achieve the objectives, consistent with the accepted strategy.

Alberta Environment is carrying out comprehensive planning studies on each of the river basins in the province. While the SSRB has been given high priority, work is also underway in the other basins. In particular, the issues of drainage and erosion control on agricultural land, of water supply for both municipal and industrial use, and of water quality are of concern in northern Alberta, and should be dealt with promptly.

THE PUBLIC HEARINGS

The Role of the Alberta Water Resources Commission

The Alberta Water Resources Commission was formed in December 1982, with a mandate to assess and review long term water resources planning and to advise the Government on policy respecting water resources. Members of the Commission are from the Legislative Assembly, from the general public, and from the Departments of Environment, Agriculture, Municipal Affairs, Economic Development, and Energy and Natural Resources.

As Alberta Environment neared completion of phase one of the Planning Program, the Water Resources Commission was charged with holding Public Hearings into the Program according to the following terms of reference:

1. Hold public hearings at a sufficient number of centres throughout the South Saskatchewan study area as to provide ample and convenient opportunity to the public to apprise the Commission of their views on the results of the planning programme;

2. Conduct hearings as informal, information gathering events so as to encourage as extensive public participation as possible;

3. Receive and consider public briefs and evaluate the planning programme's study results in the light of this information; and

4. Make recommendations to the Lieutenant Governor in Council on all matters heard and received.

The people appointed by the Government to the Hearings Panel were:

Henry Kroeger, M.L.A. Chinook - Commission Chairman

Mr. Kroeger was first elected to the Legislative Assembly in 1975 and served as Minister of Transportation from 1979 to 1982. He has been chairman of the Water Resources Commission since its inception in 1982. Previously, he was a farm equipment dealer from the east-central part of Alberta.

Bob Elliott, M.L.A.Grande Prairie - Commission Vice-Chairman

Dr. Elliott is an agricultural research scientist. He is a past mayor of Beaverlodge and has served as the MLA from the Grande Prairie region since 1982.

Margaret Lounds - Commission Member

Mrs. Lounds has been a public member of the Commission since 1983. She has been active in several water-related organizations in the Calgary area, including the Calgary River Management Advisory Committee, and the Calgary Parks and Recreation Board.

K.C.(Kim) Mackenzie - Commission Member

Mr. Mackenzie is a planner and principal in the firm of Mackenzie Spencer and Associates Ltd., an Edmonton based consulting firm specializing in urban and regional planning. He was a public member on the Commission from 1983 to 1986.

Robert(Bob) Wells - Panel Member

Mr. Wells is a retired engineer from Lethbridge. Formerly with the Prairie Farm Rehabilitation Administration (PFRA), he was involved with construction, operation, and maintenance of many of the major irrigation headworks in southern Alberta. Mr. Wells replaced the late Justice M. M. Porter, a Commission member, on the Hearings Panel.

The Panel held Hearings in 10 centres throughout the South Saskatchewan River Basin, beginning in Calgary on November 6th and ending in Red Deer on December 12th. Fifteen days of public presentation and discussion produced 223 briefs and nearly 5000 pages of transcript.[1]

Much of the credit for the public interest shown toward the Planning Program and the Hearings is due to the extensive public information program conducted by Alberta Environment. Results of their studies were presented in a series of reports that were made available at libraries and display centres throughout the basin. Over 10,000 copies of the Summary Report were distributed. Public Participation Coordinators in the four principal sub-basins held several rounds of public meetings throughout the region. Well over two hundred public groups and innumerable individuals were contacted during the course of the program.

The information received from the public was catalogued by AWRC staff. It was then organized by subjects of concern with the aid of a computer and was analyzed qualitatively to ensure that all relevant viewpoints on different issues were considered, and to identify areas of consensus, differences, and regional concerns that might otherwise have been lost in the overwhelming volume of information received. Subsequently, Panel members clarified points of information with representatives of various government departments.

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[1]Appendix 1 lists the location and dates of each session of the Hearings, Appendix 2 gives the names of those giving presentations and/or briefs, and Appendix 3 lists the locations where the transcripts are available to the public.

Results

During the Hearings, the public was asked to provide the Panel with input regarding three fundamental policy questions:

1. **Priority of use** - What priority should the Alberta Government establish for various water uses, such as irrigation, fish habitat, recreation, and hydro generation?

2. **Management** - How shall water be managed to support these uses?

3. **Allocation** - How much water will each of the Red Deer, Bow, and Oldman Rivers contribute to the amount that Alberta must supply to Saskatchewan each year? [2]

The Panel received presentations from a variety of user and interest groups, including municipalities, industry, farm organizations, environment and recreation groups, native organizations, and Government. A quarter of all the briefs presented came from individual citizens, indicating a genuine public concern about water management in the basin. Generally, the quality of the presentations showed a considerable understanding of the complex issues involved in water management. The range of responses to the policy questions posed was as varied as the backgrounds of the presenters. Every issue discussed was characterized by a wide diversity of viewpoints.

Most presentations to the Hearings expressed concern regarding potential water shortages and increasing conflicts as more users compete for a limited resource. The overall tone of the input, however, was that the situation could be managed well, and there was underlying optimism about the future. Presenters were hopeful and optimistic that innovative technologies and management could provide the solutions necessary to handle supply and distribution problems. The public expressed desire for cooperation among water users, and emphasized the need for multipurpose use management and for protecting the water resources of the SSRB. They recommended making more effective and more efficient use of available water supplies. Security of supply, for various uses, and protection from pollution stood out as important issues in many presentations. Many briefs noted that, above all, there is an obligation to preserve and to protect the water resources and accompanying environment of the basin, not only for the present, but also for future generations.

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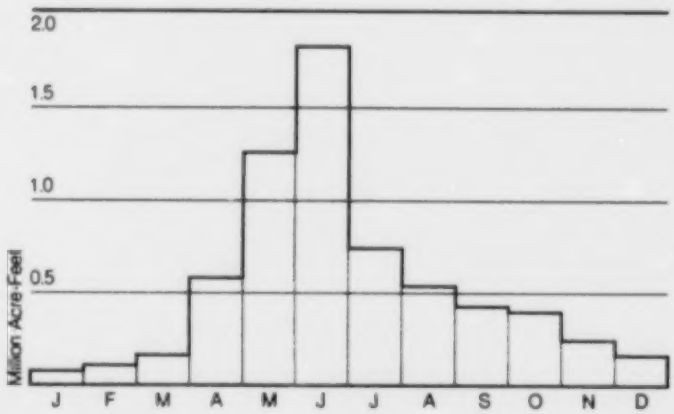
[2]The Master Agreement on Apportionment (Appendix 4) between the prairie provinces and the federal government allows Alberta to consume 50% of the natural flow volume of the South Saskatchewan River each year. The remainder must be passed on tc Saskatchewan.

This report summarizes the Panel's evaluation of the information produced by the Planning Program and presents recommendations for the planning and management of the SSRB. The Panel feels that these recommendations are appropriate for Government consideration and that they respond to the concerns expressed by the public during the Hearings.

WATER SUPPLY AND USES IN THE SOUTH SASKATCHEWAN RIVER BASIN

THE WATER SUPPLY IN THE SSRB

The South Saskatchewan River Basin comprises about 20 percent of the land area of the province and yields, on average, approximately 7.7 million acre-feet of water annually. The majority of the flow, about 75%, comes from the snowpack that accumulates in the mountains and foothills. About 60% of the annual snowmelt flows from the steeply sloped upper river reaches and through the system very quickly between mid-May and mid-July. The rest of the annual flow comes from precipitation during the summer and fall months. Figure 1 illustrates the volume of stream flow through the South Saskatchewan in each month of a typical flow year (1980).



NATURAL FLOW HYDROGRAPH
FOR THE SOUTH SASKATCHEWAN RIVER BASIN, 1980
(below confluence with Red Deer River)

Figure 1

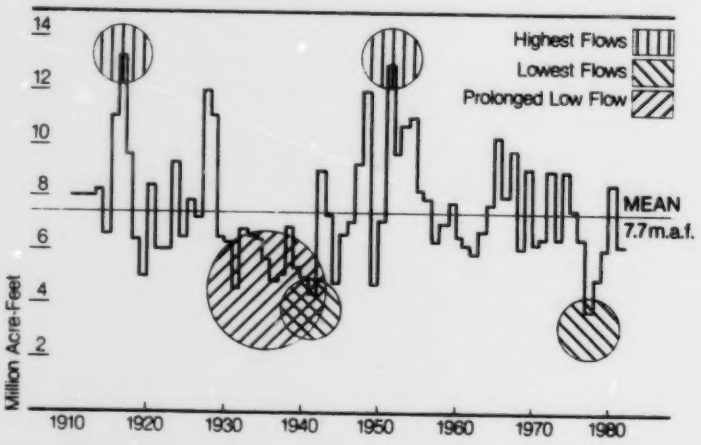
The South Saskatchewan River system is made up of three principal rivers and several important tributaries (Figure 2). The principal rivers are the Oldman and Bow Rivers, which meet near Bow Island to form the South Saskatchewan River, and the Red Deer River. The latter joins the South Saskatchewan just east of the Provincial boundary in Saskatchewan. The Bow River sub-basin contributes, on average, 43% of the total basin flow; 36% comes from the Oldman River sub-basin, which includes three tributaries, the St. Mary, Belly and Waterton Rivers. The remainder (21%) flows from the Red Deer River sub-basin. Other sources of water in the basin include lakes, wetlands, and groundwater

SOUTH SASKATCHEWAN RIVER BASIN

Figure 2

aquifers. These are all very limited sources, however, and provide only localized supplies.

In terms of absolute quantities, the volume of water available in the basin is sufficient to meet projected demands well into the future. The availability of water, however, often does not coincide with either the timing or the location of the need. The supply/demand conflicts which arise are a result of the wide variation in seasonal and annual flows in the basin. Total basin flow has ranged from a high of 13 million acre-feet to a low of 4 million acre-feet annually. The composite hydrograph (Figure 3) illustrates the wide variation in annual flow amount as well as the years with extremes of low or high flows.



COMPOSITE NATURAL FLOW HYDROGRAPH - SOUTH SASKATCHEWAN RIVER, 1912 - 1982
(below confluence with Red Deer River)

Figure 3

The discharge rate during periods of severe low flows conditions and high withdrawals has dropped to near 1500 cfs at the Saskatchewan border. Since there are essentially no tributaries east of the foothills region, development requiring water must either be concentrated along the main river stems, or be serviced with extensive distribution systems.

River flows are currently controlled on both the Red Deer and the Bow systems. The Dickson Dam provides for flow regulation of the Red Deer River. There are many small dams, control structures and off-stream reservoirs on the Bow system, both in the headwaters of the tributaries (for power generation) and further downstream to supply municipal and agricultural needs. The St. Mary, Waterton and other off- and on-stream reservoirs

provide control for tributaries of the Oldman system. The Oldman River dam, now under construction, will provide flow regulation and a major storage reservoir on the Oldman River itself.

The quality of water in the SSRB is generally very good. Most users who depend on groundwater do, however, experience quality problems. Surface water quality may also deteriorate downstream of major centres, especially during periods of low flow, requiring more pre-use treatment by downstream users.

THE USE OF WATER IN THE SSRB

Water use in the basin can be classified as either consumptive or non-consumptive. Consumptive users, those who withdraw water and do not return all of it, include municipalities, irrigators, and industry. Non-consumptive uses include the maintenance of fish and wildlife habitat, recreation, aesthetic features and hydroelectric power generation. In addition, stream flows are used to assimilate wastes.

Municipal and Domestic Use

Over one million people reside in the SSRB. The majority of them (71%) live in the four large urban centres of Calgary, Lethbridge, Red Deer, and Medicine Hat, and account for over 90% of the total municipal withdrawals from surface water in the basin. The remaining 10% is used by 67 smaller communities, (total population 110,000), 32 of which obtain their water through the Irrigation Districts' works, 6 through a regional water line from the Red Deer River and 29 directly from surface water sources. The other residents of the basin, 180,000 people living on farms and in approximately 100 rural communities, depend on groundwater and wells, rather than surface water, for their household needs. While municipal use accounted for only 3% of the surface water consumptive use in the basin in a low flow year (1977), the security and the quality of the supply are of paramount importance to the residents.

Water shortages are occasionally a problem in the larger centres during periods of peak summer demand. These shortages are generally a result of the inability of water treatment plants to keep up with the demand, rather than an actual supply shortage. Shortages also occur in winter in some of the communities which have to store enough water for the period when irrigation canals are shut down or streams are frozen. Shortages occur in rural communities where natural conditions cause periodic shortfalls, with inadequate groundwater and/or surface supplies.

The relatively small consumptive total attributed to municipal use belies the substantial impact of population centres on the

water supply. The large urban centres all provide secondary sewage treatment and Calgary additionally treats to remove more phosphorous. Most rural communities have secondary sewage treatment, though some of these facilities are less efficient than others. The use of the assimilative capacity of the rivers to dilute sewage effluent is an accepted practice in the province. This, however, requires certain minimum flows to meet downstream water quality standards. Thus, sewage effluent can, in effect, be considered a consumptive user of water, since the flows used for this purpose are unavailable for other uses. Increasing use of out-of-stream methods for sewage disposal, such as effluent irrigation, would reduce the amount of stream flow required for assimilation. Urban centres also impact indirectly on water demand through the need for electric power generation, either by thermal or hydro-electric plants, both of which require large volumes of water.

Agricultural Use

Agricultural activities, both dryland and irrigated, occupy three-quarters of the land area of the basin and are important to the overall economic health of the region and the province. While 83% of the cultivated land is devoted to dryland crops, over half the farms in the basin and one million acres of land are irrigated. Irrigation is the principal water user in the basin, accounting for approximately 96% of water consumption in a low flow year and averaging 1.7 million acre-feet annually. This total is subject to wide variations as the amount of irrigation withdrawal in each year depends directly on the prevailing weather conditions. As with withdrawals for municipal use, the peak demand for irrigation water occurs during summer when the natural stream flows are low.

Historically, irrigation was developed by the railways on blocks of land acquired from the crown as a means to attract settlers to the area. From a financial perspective, the projects were never a success for the development companies and they eventually divested themselves of ownership. However, irrigation was a boon to the local area and has continued to provide economic stability for much of the southern Alberta region.

Most irrigation today is concentrated in thirteen Irrigation Districts, which occupy lands in the region from Calgary east to Medicine Hat and south almost to the US border. In 1984, 1.125 million acres within these districts were assessed for irrigation, and a total of 1.004 million was actually irrigated. A relatively small amount of land, 175,000 acres, is irrigated privately, generally by systems which pump directly out of the waterway onto adjacent land. While actual irrigated acreage varies widely from year to year depending on natural precipitation, the assessed acreage, which has steadily increased by 20,000 to 30,000 acres per year since the early 1970's, provides

a good measure of the demand for irrigation. This increase in demand for irrigation can be attributed, in large measure, to the advent of modern sprinkler systems which opened up lands previously considered non-irrigable using traditional gravity systems. The Alberta Government has responded to the increased demand by committing over $600 million for rehabilitation in existing districts and by developing irrigation in conjunction with construction of the Sheerness and Deadfish projects.

Market opportunities vary over periods of time and, in fact, from year to year, and have a dynamic influence on the cropping patterns. Irrigation has given the farmer the ability to diversify to meet these opportunities. At present, irrigation agriculture supports three main product groups. The current distribution of cropping and use patterns is as follows:

- grains, principally soft white spring wheat;
- red meat, fed with barley and hay produced under irrigation; and
- specialty crops, including corn, sugar beets, potatoes, beans, sunflowers and vegetables.

Grains account for 56% of irrigated acreage and 54% of the total crop value. Livestock feed accounts for 34% of irrigated acreage and 30% of total crop value. Specialty crops use 9% of the irrigated acreage and produce 15% of the total value of crops produced. The curtailment of sugar beet production for 1985 resulted in temporary conversion of cropping to soft white spring wheat, beans, and other products. Approximately 31,000 acres were returned to sugar beet production in 1986. Irrigation provides the capacity to diversify production and to alter crop types when market shifts occur.

Soft white wheat acreage has been increasing rapidly. It is a grain which, in Alberta, can only be grown consistently under irrigation because this gives the producer the ability to control protein content, important to satisfy market requirements, and to obtain high yields. It is an important product for export. Irrigation has had a significant impact on the livestock industry in southern Alberta, being able to supply a secure source of feed for cow-calf operations throughout the region. Many feedlots are concentrated in irrigation districts, where, with their access to feed supplies, they provide a market for feeder calves from dryland regions, thus stimulating the beef industry overall.

Specialty crops are high value products, with high yields under irrigation and cannot generally be raised in dryland farming conditions. They are very sensitive to market availability which can change or fluctuate rapidly. But their higher value per unit

warrants expansion of this type of production as markets can be procured.

A number of estimates of irrigation's contribution to production have been made. When viewed in the context of the southern Alberta region, where the irrigation acreage is located, the impact represents approximately 28% of the production in that area (based on 1983 figures). The Panel considers that estimates in the range of 14% are conservative representations of the contribution of irrigation to total provincial production.

A most significant benefit from the increased value of production on irrigated lands has been the ability to stabilize overall regional production. This was particularly evident in 1984 when drought conditions caused a 35% decline in total output in southern Alberta compared to 1983. It is estimated that without the buffering effect of irrigation production, this decline could have reached as high as 45%. This buffering potential is impressive when compared to the relatively small acreage being irrigated in comparison to total agricultural acreage.

Industrial Use

Industrial use of water is limited in the basin and accounts for only about one percent of total surface water consumptive uses. Most of the industries are concentrated in or near the four major urban centres, receiving their water and discharging their effluent through the municipal systems. While the numbers are small relative to total consumptive use, industrial use has a significant impact because of the relatively high withdrawal requirements on a continuous basis. For example, in 1981, industrial users withdrew 146,000 acre-feet of water and returned 116,000, consuming 30,000 acre-feet. Unlike irrigation water use, which is seasonal in nature, industrial use is quite constant throughout the year. The significant effect or impact of this withdrawal comes during the low flow periods, especially the winter months.

The single largest consumer, accounting for 23% of the total industrial consumption of surface water, is oilfield injection. The quantities involved are relatively small, 7,000 acre-feet annually, but much of it comes from small tributaries with naturally low flows. The oil industry also uses groundwater for oilfield injection and while this use is minor in the SSRB, (57 projects with a total allocation of approximately 3,000 acre-feet), it does have the potential to affect farm and small rural communities' well supplies.

The availability of water to attract and sustain industrial development and thereby help stabilize the economy of an area is also an important consideration for water management in the basin.

Habitat and Recreation Uses

Water is important within a river channel, as well as when it is withdrawn. It provides habitat for fish and other aquatic animals, recreation opportunities, and streambank and floodplain vegetation. This vegetation is habitat for terrestrial wildlife and birds, and contributes to the general aesthetics of the river valley itself. Periodic floods sustain this vegetation and help maintain good streambed habitat conditions. In addition, controlled flows can provide ice control and sediment flushing.

Sports fishing is a popular recreation activity in the SSRB, both for residents and tourists. The upper reaches of the main streams and their tributaries are cold water zones, which provide habitat for various trout species and for mountain whitefish. Popular fishing areas for cold water species include the Crowsnest, the upper Oldman, the Highwood, tributaries of the Red Deer near Sundre, and the Bow from Calgary to Bassano. The Bow and Crowsnest fisheries are internationally recognized and heavily utilized by both residents and tourists. In the lower, slow-flowing, warm water reaches, northern pike, walleye, sauger and goldeye are common, with a species of sturgeon occurring in the South Saskatchewan River. Commercial fishing, primarily for whitefish, takes place on the lakes and irrigation reservoirs during the winter. Fishing in the warm water reaches, though not as important from a tourist standpoint, is a popular recreation activity for local residents. The irrigation system of reservoirs and canals has enhanced the fish habitat and hence the fishery potential within the basin, providing much of the warm water fishing and some of the other recreational opportunities. Without this system the fishery, both sport and commercial, would be limited.

Terrestrial wildlife and birds also depend on river valleys for food, water, shelter, nesting habitat and movement corridors. The vegetation in river valleys is a key element in wildlife use, particularly in the prairies, where it provides unique habitat. The presence of various animal species is, in turn, an attraction for recreation users.

Water oriented recreation opportunities are limited in the basin, with about half of the activity centred on the major rivers, and a few large lakes and reservoirs providing the rest. Recreation activities using the rivers and their valleys include fishing, boating (power, canoe and kayak), camping, hiking, nature watching and hunting. The amount and type of use varies with proximity to urban centres; amount, flow rate and quality of water; the nature of the river, its valley and vegetation; and the availability of access and facilities. Fishing, as discussed above, is very popular, as is boating. Boat traffic is highest on the Bow River downstream of Calgary and on the Red Deer River between Red Deer and Drumheller. The

upper reaches, especially on the Bow and Red Deer systems, are popular for kayaking and white water canoeing. Most river oriented recreation is multi-purpose: boating, camping, swimming, fishing and nature appreciation are related and often complementary activities, though their flow requirements may differ. The flows on the Bow between Calgary and Bassano have generally been adequate for most uses. Elsewhere, flows are not always sufficient to permit boating, because of natural low flow conditions and because the demand for water for boating coincides seasonally with the need for irrigation diversions and for hydro storage.

The river valleys are also important heritage sites for fossil remains and archeological findings. These provide additional incentive for recreation activity, especially on the Red Deer River downstream of Drumheller. The location of significant heritage sites also affects development on and near the rivers.

Habitat and recreation uses contribute to the local economy, though they do not have the same economic impact as irrigation and industrial uses. More importantly, each contributes to the quality of life of residents of the basin. The needs of habitat and recreation uses also tend to overlap, rather than being additive. That is, the assurance of suitable conditions for one use often also provides, partly or completely, for another.

Lakes and Reservoirs

Lakes and reservoirs provide important benefits within the basin for irrigation, for hydro-electric power generation, and for recreation - primarily boating, fishing, swimming, and camping. Outside of the National Parks, there are 32 lakes in the basin which are of sufficient size to permit recreation use. Of these, the three largest and deepest lakes, Sylvan, Gull, and Buffalo (all in the Red Deer basin), supply major recreation opportunities. They are used by many non-basin residents, primarily from the Edmonton area, as well as people from the SSRB. Only two other lakes, Little Fish in the Red Deer basin, and Beauvais in the Oldman, have Provincial Parks. Of the 32 lakes, 7 are used almost exclusively for recreation, 20 for both agriculture and recreation, and the remaining 5 only for agriculture. Many of these lakes are very shallow, which limits their recreation potential. Most lakes provide waterfowl nesting habitat and some wildlife habitat, and some of them are also important staging and feeding areas for migrating waterfowl.

Major irrigation reservoirs also provide some recreation opportunities; in the drier areas of the basin they are often the primary sites for water based recreation. In the SSRB, there are 28 reservoirs with a storage capacity greater than 4,000 acre-feet. Recreation use has been measured or estimated for the 10 most important outside the urban areas. These reservoirs, in descending order of importance, are Travers, Chain Lakes, Kehoe

Lake, St. Mary, McGregor, Paine Lake, Milk River Ridge, Little Bow, Waterton, and Jensen. Minimum levels, below which recreation activities are severely hampered, have been determined for each of these, as well as for the Dickson Dam reservoir. During dry or low flow summers, levels must be lowered below these minimums to support irrigation. But, by planning for recreation and wildlife use in conjunction with irrigation, it is possible to design a multi-purpose reservoir in which the drawdown impacts on other uses are not as severe.

In addition to these lakes and reservoirs, Ducks Unlimited has approximately 290 projects in the basin, ranging from 1.2 to over 5000 acres in size. Though the primary function of these projects is to provide waterfowl nesting habitat, many are multi-purpose, being used for fishing, other recreation, some irrigation, stock-watering, and controlled hay field flooding.

Hydro-electric Power Generation

Hydro-electric power generation requires alteration of the natural river regime through storage and control of flow; however, there is essentially no net loss of water in the system. It is, therefore, considered a non-consumptive use. In the SSRB, TransAlta Utilities operates 11 hydro-electric generating plants on the Bow River and its tributaries upstream of Calgary. These plants have a combined capacity of 325 MW, representing only a small percentage of the total electric output in the province, the majority of which is being generated by thermal power. However, hydro-electric installations are important to the overall functioning of the power system because of their ability to satisfy daily peak loads and respond to instant fluctuations in the base load. The operation of the hydro-electric system affects both the daily fluctuations in river flows, and, to some extent, the long term hydrologic patterns. Daily operating patterns cause downstream flow fluctuations. These have an impact on fish movements, fish habitat and on natural vegetation; and, without mitigation and flow control, can cause some scouring and erosion of the streambed. Water releases in winter can also lead to ice buildup which will affect bridges and structures downstream and produce some potential for flooding; TransAlta Utilities does, however, operate one dam, Bearspaw, primarily to control this problem for Calgary. Normal operation of power reservoirs on an annual basis leads to a decrease in flows in the rivers during the spring and summer months and an increase in the flows during the winter months. This operation pattern has both positive and negative effects. The storage of summer flows for use in the winter conflicts with peak flow demand periods for irrigation. The control of flow for hydro-electric power production also reduces the natural flushing action of the river, which can result in increases in weed growth and a decline in adjacent riverine habitat. On the other hand, increased winter flows improve fish

habitat and increase the dissolved oxygen content and assimilative capacity of the river. The operation of hydro-electric reservoirs can result in erratic reservoir levels, thus conflicting with many recreational uses including boating, swimming, and other activities; yet some reservoirs still receive high levels of recreational use.

ISSUES AND PRINCIPLES

This report and its recommendations are based on the following issues and principles:

ISSUES

- Water resources in the basin are limited and highly variable in time and place.
- The needs for these resources will increase with population growth and with agricultural and industrial expansion.
- The potential for water pollution increases as population and activity grow.
- The greatest water needs occur during low flow seasons and years. Conversely, water demand is usually lower when natural flows are high.
- There is a public desire for adequate, stable and safe water supplies for all uses.
- Certain water uses are in conflict with others.
- External forces, including the need for investment equity with other parts of the province, the impact of marketing the agricultural and industrial products, and the overall provincial economy, influence water management decisions.
- Given the above, how do we both continue to use and sustain the water resources of the basin as the upper limits of supply are reached?

PRINCIPLES

- The Apportionment Agreement must be satisfied.
- Water should be used to achieve economic and social goals within the basin, but this should be accomplished in an environmentally sensitive manner. In this regard, important points include the following:
    - safe drinking water, reasonably attained;
    - Albertans value the basin's productive agro-climatic conditions, natural areas, fisheries, wildlife,

recreation sites, and areas of historic and geologic interest;

- safe instream water quality; and
- stability and diversification of agriculture are important goals.

- Security and consistency of supply along with safe water quality for the public at large are considered essential.

- The principle of multi-purpose use should be the basis for planning and management. In certain situations, it may be necessary, after protecting a baseline flow for the safety of instream life and downstream users, to zone portions of the system largely for major beneficial uses, such as the operation of a reservoir to service irrigation or the preservation of a specific reach of a river in reasonably natural condition.

  Mitigation is a fundamental element of this planning and management.

- Technical solutions to secure water supply and quality must be chosen carefully to minimize environmental impact.

- The South Saskatchewan River system must be considered as a whole for distribution of uses and for management. The integrity of the individual watersheds within the basin should be protected by maintaining safe instream flows.

- High, but practical, levels of water use efficiency and conservation are required.

- Because of the uncertainty associated with future water demands and in recognition of the limitations and unpredictability of the supply, the system should be managed to retain reserve capacity.

WATER MANAGEMENT ISSUES

USES

Municipal and Domestic Use

While municipal/domestic consumption of water is about 3% of the total consumptive use, this use and supply commands the highest priority under the current policy. Those urban centers and users within reach of the main stem rivers have had sufficient supply to meet demands, and those shortages which have occurred are basically because of limits in the capacity of the treatment and delivery systems to meet peak withdrawals. These withdrawals are very similar in form and timing to irrigation consumption during the summer; in other words, peak withdrawal periods for municipal and domestic use, and irrigation, generally coincide.

There are many factors involved in considering policy respecting municipal/domestic use.

In the vicinity of large centers, the accumulations of sewage effluent require fairly substantial river flows to provide for safe instream assimilation. As basin populations increase and demands for irrigation or other large scale withdrawals increase in parallel, optimum limits will have to be established such that withdrawal from the river will still leave residual flows of sufficient quantity to carry out the dilution and assimilation function. In many respects, this capacity to effectively assimilate treated wastes may be the most critical water supply issue affecting our urban populations centres. While the focus of concern for the capacity of receiving waters to assimilate treated effluent has related more to the larger urban areas on main stem rivers, equally intense problems have been observed where treated effluent from smaller centres is discharged into smaller tributary streams which have wide flow variations throughout the year.

Many of the smaller communities in the basin are situated on tributary streams of limited capacity, some are serviced by groundwater supplies and others by a combination of both. In the supply facility for many of the smaller centers, sufficient storage capacity to cover sustained low flow yields is considered a major requirement. During the Hearings, a secure water supply for such communities was specified as a necessary long term requirement. It may be observed that the smaller and more variable the stream source, then the larger the required storage will be, proportionately, to satisfy the continuing municipal needs of the affected communities. A practical procedure for storage maintenance and cleaning is necessary to maintain quality and minimize treatment costs.

Improvements have been made, over the years, to the municipal supply of water in the SSRB which should be recognized. Some thirty-two communities now obtain their domestic and municipal water supplies from irrigation systems. Many of these communities, which were previously on groundwater supplies of low quality, have been able to upgrade their water quality substantially and also ensure a secure quantity of water and better delivery systems. In addition, a significant number of the farmsteads in the basin now obtain domestic supplies from irrigation systems by pumping from canals and pipeline supplied storage, or by hauling from such sources to on-farm storage. The importance of this supply has been grossly underrated in considering the value received from irrigation storage and conveyance systems. Increasing domestic use of irrigation water through the development of rural pipeline distribution systems is anticipated, particularly for the dryland farming units.

The vagaries of weather in the last two or three years have caused pressures on community storage and, while these are not new issues, the increasing expectations of people throughout the province is that a secure supply, similar to that of city dwellers, should be achieved. During the Hearings, there was a significant amount of discussion on the need for regional distribution systems as utilities. The provincial experience in the vicinity of Edmonton and Red Deer indicates the advantages, in those situations at least, of large scale water treatment facilities and regional distribution systems. Currently the Edmonton system reaches to 17 smaller cities, towns, and villages and six rural counties and Municipal Districts, as far away as 90 km. The Red Deer system similarly provides treated water to a line of communities as far south as Crossfield and has stabilized the water supply that was previously deteriorating. In smaller scale situations, the potential for utility systems supplying a number of towns should be carefully considered.

The scale or size of supply systems should allow for reasonable increases in water demand, but should also be designed such that they can be expanded as growth occurs, rather than building in major oversizing when real growth is not readily assured.

In general, current Government policy supports safe usable water in sufficient quantity to satisfy public use requirements and instream life. It can be concluded that, with increasing demands for withdrawals for consumptive purposes together with continued use of streams for waste assimilation, the balance between withdrawals and residual flows will need to be prescribed so that the residual flows will remain safe for downstream use and for the instream life.

The subject of water conservation by municipal water users has not been a pressing or recurring issue, except in some specific

communities where there have been chronic shortages in water supply. Limits in the capacity of treatment and conveyance systems have occasionally caused restrictions where there was a surplus of raw water supply.

Some proponents emphasize that the greater consumption experienced where "metering" is not done is an indicator that conservation would be effected should water delivery charges be made on measured amounts. There have been objections to introducing universal municipal metering, citing cost of installation as a major obstacle. The Panel believes, however, that this view will change with more frequent supply interruptions in high demand periods. Alternatively, the potential costs for expanding treatment and conveyance systems need to be considered, particularly recognizing that these costs will be much higher if unmetered consumptive use levels, as experienced, are to be accommodated. High water consumption generally translates into similarly higher sewage treatment volumes and costs.

Recommendations

1. For any stream which provides water for consumptive uses and for waste assimilation, it is recommended that limits be established to restrict withdrawals or effluent discharges, or both, such that the resultant downstream flow is of sufficient quantity and of safe quality for the protection of downstream users and instream life. Using the limiting controls cited above, when necessary, to optimize the various uses, could reduce future costs for more intensive effluent treatment.

2. A secure supply of water is now the public's prerequisite for an acceptable quality of life. The communities which receive their supplies from the smaller tributary streams are occasionally subject to supply shortages, particularly after extended drought and during the seasonal low flow periods. These shortages appear to be more frequent and intense when smaller streams are the source of water. It is recommended that a review of storage capacity and water use experience be conducted to clearly identify those centers and circumstances which would call for increased storage and potential for Government support.

3. Many communities obtain their municipal water supply from groundwater sources. A significant number of the centers involved have had to restrict water use on a frequent basis and, additionally, have had to use highly mineralized water requiring special treatment. Many of the systems conveying these waters have required high maintenance expenditures and have deteriorated at a higher than normal rate. The public perception is also that some of these water supplies have an

adverse effect on public health. It is recommended that assistance programs for the development of water supplies should, if necessary, be extended to include sufficient treatment for low quality waters to improve the quality for human use and to reduce the deterioration of the water systems.

4. There appear to be important advantages in some circumstances for regional utility systems to serve groups of rural communities. It is recommended that the Government consider policy and processes to assist these communities in evaluating optimum water supplies. While the feasibility of regional utility systems should be tested a case at a time, the Panel recommends support to such investigative processes where there are demonstrated deficiencies in supplies affecting a number of communities and adjacent rural populations.

5. It is recommended that the potential for disposing of effluents on land in an irrigation process receive comprehensive investigation, supported by the Province, to more clearly define whether such disposal processes are reasonable and can be used instead of discharging into streams. This evaluation should not only deal with total effluent disposal, but also with the possibilities of partial disposal, part-year disposal, and low flow period disposal, as variations.

6. While water treatment and conveyance systems and household plumbing are basically municipal and private matters, a great deal of public cost occurs when conservation is not practiced.

   It is recommended that a universal policy of water metering for municipal water supply be adopted for all new supplies and that a program of conversion over a reasonable time period apply to the other existing users. In general, charge rates for water supply could be established to recover meter installation costs over a period of time, in addition to delivery, treatment, and other service costs. It is the Panel's position that charging for supply development, treatment, delivery and servicing, on a measured basis, is an essential step for the efficient and conservative use of water through municipal systems.

Habitat and Recreation Use

Water, be it in creeks or rivers, lakes, small wetlands or reservoirs, is unalterably associated with the surrounding land to provide habitat for fish and wildlife, and recreation opportunities for residents and tourists. These uses are interrelated and overlapping, one river reach or reservoir being able to fulfill several needs. Requirements for water for these uses tend to be seasonal in nature; most recreational use and waterfowl nesting needs being in summer, for example. Other wildlife needs vary with time, depending on the species; however, a year round water supply is important to most. The uses of water to provide habitat and recreation are often in conflict with the main water user, irrigation, during the summer months when flows are naturally low, when withdrawals are made for irrigation systems and when irrigation reservoirs are drawn down. On the other hand, the irrigation systems have provided a source of water based recreation and habitat where previously little existed.

Fish Habitat

The requirements for fish habitat depend on the species, the location and the time of year. The basic requirement is for sufficient water of suitable quality. In river systems the quality is determined by natural factors and by the amount of wastes being assimilated in the flow available. Generally, quality is not a problem in the SSRB although one river, the Highwood, has experienced occasional problems during hot weather and low flow periods in reaches which assimilate wastes from High River below the major irrigation diversion to the Little Bow. Mercury levels are also a quality consideration. High levels have been found in fish in and below some reservoirs and in Bow River trout. Although the mercury originates from natural sources, these levels have been high enough to warrant warnings regarding human consumption. The sources and the processes resulting in increased levels are not, as yet, fully understood, but they are being studied by Alberta Environment.

The amount of water necessary for fish depends on the shape of the channel and the use by fish. Some species, for example, require a strong, "attracting" flow to induce them to move upstream to spawn. At other times of the year flows must be high enough to cover the areas which provide food or resting spots. Water levels can be a problem on unregulated streams during low flow periods, especially if diversions for other uses take a high percentage of the available water. On regulated streams, problems for fish result from the erratic nature of the releases, as with hydro dams; or from residual flows which are potentially too low to support fish life. Dams can, however, be beneficial to fish populations below them if the habitat needs are planned for and included in the design and operating regime of the

structures. Ideally this would include dedicating sufficient stored water to be released, as needed, for maintenance of fish habitat, provision of attracting flows and provision of flushing flows. The latter, which occur naturally as runoff peaks, are necessary where silts have covered spawning beds and food sources. The other main concern regarding fish in the rivers of the SSRB is blockage of their movements by dams and weirs, and the reduction of upstream habitat in the flooded area.

Because different species use different rivers and parts of rivers at different times, their needs and importance should be considered on a reach by reach basis. It is also important to acknowledge that, especially on the smaller tributaries, the natural situation itself does not always meet all the requirements for fish habitat. In very low flow years the species may be able to do little more than survive or migrate, with reproduction being below normal.

Reservoirs provide important fish habitat which would not otherwise exist in the basin. Some reservoirs are stocked with trout and others have naturally occurring species. The prime purpose of a reservoir, to provide water for agricultural, municipal or hydro use, requires drawing down the level, often to a very great extent. This has a negative impact on the fish which feed and spawn in the shallow edge vegetation. This impact can be mitigated in many instances, as demonstrated by the Badger and Crawling Valley reservoirs, where multi-purpose values warranted design and construction adaptations to stabilize water levels in part of the reservoir.

Other Wildlife Habitat

The river valleys, reservoirs and irrigation canals also provide much of the prairie terrestrial wildlife and bird habitat in the basin. Both the water and the associated upland vegetation are important for supplying food, cover, nesting areas and safe movement corridors for these species. Deer and other ungulates require the water and the protection afforded by the creek and river valleys. Geese have traditional nest sites on many of the rivers in the SSRB, and the higher cliffs of some of the rivers and reservoirs provide nesting sites for prairie falcons and other birds of prey, to mention only a few of the many species in the basin. It is not possible to set an amount of water that is necessary to meet these needs. It is, however, necessary that some flows remain to sustain the vegetation and maintain accessible water. Occasional floods were considered by some presenters as being necessary to regenerate the cottonwood trees along the rivers. Deliberately releasing flood flows for this purpose could, however, have undesirable consequences for other uses, so other methods of maintaining the cottonwood groves should also be investigated.

Seepage has created prime pheasant habitat alongside many of the irrigation canals in the basin. Much of this habitat is being lost as the rehabilitation program proceeds with lining and other methods to reduce seepage. Indications are that some vegetation will regrow. Reduction of seepage is important to improve irrigation efficiency, to reduce the increasing salinity problem and to reclaim lands that rightfully belong to the landowner for use in cropping. Opportunities exist, however, to use spill water and marginal lands to create, under controlled conditions, some habitat for upland gamebirds and associated species. Pheasants are a valued resource in the basin which should be maintained as much as possible.

Reservoirs also create habitat for wildlife, primarily ducks. There are many projects in the basin which include provision for duck nesting habitat. This is a use which can be readily accommodated into reservoir operation without seriously affecting the water supply for other uses. Any plan must acknowledge and protect the farmers from any adverse effects of increased duck populations. There are also many small natural wetlands which are important to various wildlife species, especially ducks, and to the overall water cycle of the basin. These non-saline wetlands are excellent duck rearing habitat as well as recharge areas for the groundwater system. Many farmers are interested in draining wetlands for more efficient operations. Incentives and potential compensation for crop damage should be considered to encourage the retention of some of these wetlands. Ducks Unlimited is involved in a large number of projects in the basin, both on reservoirs and natural wetlands, to create, enhance and protect existing duck habitat while, whenever possible, providing for other uses such as hay production, stock watering and fish spawning. Such projects are especially beneficial in dryland areas.

Recreation

Recreation is an important contribution to the quality of life in the SSRB and much is centered around water. Activities such as fishing, boating, hunting, camping and hiking make use of the streams, lakes and reservoirs of the basin and the natural resources associated with them. Some areas of note include:

- the Bow River between Calgary and Bassano and the Castle and Crowsnest Rivers for fly fishing;
- the Eastern Slopes, including Kananaskis Country, for a wide variety of recreation opportunities;
- the Red Deer River valley, with its prominent badlands, cottonwoods and grassland areas;

- irrigation and hydro-electric storage reservoirs, such as Crawling Valley, Lake Newell, Travers, MacGregor, and Ghost for swimming, boating, fishing and camping, windsurfing and scuba diving; and

- the Red Deer River above Sundre and other upper tributaries for white-water kayaking and canoeing.

This list is not exhaustive, but simply illustrates some of the important recreational areas.

Recreation uses only come into conflict with other water uses when sufficient water cannot be supplied to meet both needs. Irrigation uses need the water during the summer period, but low flows in rivers impede boating and reduce fish habitat. Quality can potentially also suffer, making contact activities unappealing, undesirable or unsafe. Storage reservoirs, for whatever purpose, provide much needed recreation opportunities in the basin, although the uses are not completely compatible, especially during dry periods. Drawdown of reservoirs, necessary to meet their prime objective, can, for example, result in boat launches and docks which are high and dry, shorelines which become mudflats, and water which contains odorous algae. Recreation plans for reaches downstream of hydro dams must recognize that sudden releases, to meet peak power needs, are part of the normal operating regime for these dams. Improved communication could solve some of the problems with sudden releases. TransAlta Utilities have been recognized for their cooperation in providing water for special white-water events below their storage dams. Options for lessening the reservoir level problem include creating sub-impoundments within the reservoirs, as was done at Crawling Valley and the Dickson Dam; establishment of minimum reservoir levels for recreation, as was done at Travers; or providing water specifically for recreation and habitat uses, as was done at Park Lake.

Local residents expressed, at the Hearings, their feeling that some locations in the basin do not have sufficient water-based recreation facilities to meet their needs; because of both the limited number of lakes and wetlands and the large population demand. The development of water storage projects in dryland areas should include opportunities to enhance them for recreational use wherever possible.

Aesthetic considerations are subjective and present difficulties in assessing or setting standards. An assessment of the river reaches might indicate those which should be preserved, for aesthetic reasons, in a largely natural state, with appropriate flows.

Tourism is a component of recreation use in the SSRB, with the emphasis being on attracting people from other parts of the

province and from outside the province, while encouraging basin residents to remain. Opportunities exist to enhance the recreation potential, and with it the tourist use, of the basin using the water resource. It is important that the tourism, recreation and habitat needs be included in water management planning. Towards this end, and because these uses are interrelated and can share the same water resource, implementation of an integrated system for rating river reaches, lakes and reservoirs for their importance as habitat and for their various recreation components would be beneficial.

Recommendations

1. The habitat, recreation and other uses of water in the SSRB are many and diverse, touching on the mandates of different departments at different levels of government. The use needs will increase as the population of the basin and province increases. The Panel urges the reinforcement of communication and cooperation between those responsible to ensure that as many valued uses as possible can be accommodated.

2. Habitat and recreational needs overlap and complement one another, with different factors being important in different parts of the watershed. For this reason it is necessary to determine the significance of each lake, reservoir and river reach for habitat and recreation uses. Such a rating system will involve different government departments with input from local authorities and interested groups and should include an assessment of adjacent land use.

3. It is recommended that habitat needs for fish in the river systems be considered in any management plan and reflect the priority in accordance with the ratings determined above.

   Options such as fish passage over man-made obstacles and the provision of special flows for flushing the substrate or attracting spawning fish should be considered when and where they would be effective and practical.

4. New on-stream storage structures should be designed and operated so as to enhance the valued opportunities for fish and recreational use downstream. This could include dedicating water specifically for later release for these uses. The inclusion of sub-impoundments, minimum levels and storage of water for uses other than the main purpose should all be considered. The Panel endorses the practice of considering the needs of downstream users when determining the schedule for filling a new reservoir.

Existing structures should also be examined for possibilities of providing better downstream opportunities for habitat and recreation.

5. The current practice of designing and operating reservoirs to provide for multi-purpose use is endorsed and should be continued.

6. Safe water quality is important for all water users but the needs vary depending on the use. Appropriate standards could be set on a reach by reach basis which would not be detrimental downstream.

7. Habitat for waterfowl, upland game birds and associated species is recognized to be limited, and probably declining, in the SSRB. Programs exist and new ones are being examined to address this problem. The Panel supports the principle of such programs and stresses the importance of landowner involvement at all stages from planning to implementation.

   The reduction of pheasant habitat, which appears to be associated largely with canal rehabilitation, is a problem which can be resolved given good co-operation. Priority should be given to finding marginal lands in suitable locations and providing them with water, if necessary, for replacing the lost habitat. The question of how the costs should be assessed is not yet resolved; however, they should not be a burden to the landowner.

Irrigation Use

Irrigation agriculture is the principal large scale water user of the basin.

World food requirements drive agricultural production: because of our ability to produce to export levels, we are affected by international market competition. Defining the long term market potential is extremely difficult and cannot be done in precise terms in respect to marketable products, values, and time frames. Nonetheless, there are prominent predictions which indicate significant increases in agricultural products demand into the next century. Estimates prepared for wheat markets, as an example, suggest at least a 60% increase by the year 2010 on a world scale.

The vagaries of weather and moisture, common to many of the agricultural areas of the world, suggest that more land intensive management practices will be necessary to increase and also stabilize production. While irrigation will not likely become the major influence on the massive production requirement, it can significantly enhance the stability by reducing the valleys in production which are commonly associated with total dryland farming.

Nearly all major Canadian urban centers are in high quality agricultural land zones. While development of further "new" agricultural land tracts is still a potential, this expansion is expected to be less productive. Thus, intensification of agriculture on lands capable of greater output will be essential to offset losses to urban growth and industrial developments.

Experience has shown that there is a need, at all times, to have the production capacity to take advantage of markets as they develop. Stability in this production is essential to keep markets to which products are committed. The initiatives towards freer trade will require the highest degree of efficiency in the farming management processes to make produce competitive. Additionally, diversification of products will make it possible to enter into a wider range of markets. Continual and aggressive crop improvement research will be essential to maximize production returns. Efficient irrigation systems and management will improve the opportunities for stability in production, intensification of land use, diversification in agricultural products and increased value-adding industries and employment.

Irrigation responds, directly and indirectly, to a number of the critical needs of dryland agriculture. This includes supplementary irrigation and provision of a significant source of fodders and feed grains used in dryland livestock production, particularly during dry years. The cattle industry in irrigated areas provides a market for feeder cattle raised on drylands,

especially during drought conditions. The cattle feeding industry in irrigated areas is itself a market for dryland feed grains. It is also important to note that a high percentage of irrigated acreage grows crops that cannot be produced economically on drylands, or that are specialty crops requiring irrigation. Irrigation is, therefore, complementary to dryland agriculture.

At this time, irrigation agriculture is firmly integrated into the economic and social environment of the province of Alberta, and has a major influence on these areas.

Rehabilitation of Irrigation Systems

Due to aging (some parts of the systems are approximately 80 years old) and other deterioration of much of the water delivery systems, constrictions within them, seepage losses and related land damage, the Province and Irrigation Districts have implemented a major rehabilitation program. If the current schedule for this work is maintained, the rehabilitation will be substantially completed in about 1995. A major component of the rehabilitation process is the expansion of strategic parts of the conveyance systems to increase water delivery, both in quantity and timeliness. The Panel agrees that this expansion on suitable irrigable acreages should make for efficient and effective use of the upgraded systems' capacities. In order to optimize water use, both to enhance efficiency and to conserve water for more acreage or for more intense use, improved metering and measuring will be necessary to support the essential control of the distribution systems. The importance of high levels of efficiency justify the inclusion of improved measurement and metering facilities within the terms of rehabilitation programs. For practical reasons this will be a gradual transition, but nonetheless should be undertaken progressively, since water demand is increasing.

The subject of rehabilitation costs versus benefits has received considerable comment and a variety of interpretations. Currently, the distribution of costs for cost-sharing of rehabilitation at District levels is based on a formula which has recognized credits for both direct and indirect benefits accumulatively against the associated construction costs. The Panel accepts the principle of crediting both the direct and indirect benefits when evaluating benefit distribution for proportioning of costs to be shared for rehabilitation of District systems. They also consider that for this basin, with its proven agricultural performance, public investment in irrigation agriculture is appropriate and will provide a desirable distribution of benefits to the economy of the province in general. Contrary to the views expressed by a few, Government investment is deemed to be justified where wide distribution of benefits occurs. It is acknowledged, on the other hand, that regular reviews of the

economic factors affecting the distribution of costs and benefits need to be done. As the present rehabilitation of the systems reaches substantial completion, the construction benefits and costs factors will change, therefore affecting any future formula for cost-sharing.

It is also important that a reassessment of the Operation and Maintenance requirements be made to ensure a maintenance level designed to keep the systems at a high level of efficiency and to prevent significant deterioration. This assessment will be necessary to establish costs and their assignment for future operation of the systems.

Indications from the study, from the public, and other inputs show that, as management is intensified to maximize the supply and the control of water, the infrastructure and operating costs will grow at an increasing rate. This suggests that as significant elements of expansion are being considered it will be important that the benefit-cost conditions affected by the provincial and national economies, market conditions, value adding potential, etc. be re-evaluated to test the viability of such expansions. It is also apparent that conversion of irrigation farming to higher valued production will be a pre-requisite to the development of the upper levels of irrigation expansion and will have an influence on the timing and viability of such expansions.

Irrigation Efficiency

Water use efficiency in irrigation is subject to a wide range of interpretation. There has been a lot of subjective comment about efficiencies, which may have resulted in part because of the lack of meaningful measurement data. At the irrigation systems level, water use efficiency has been generally defined in components of the irrigation facilities (i.e. headworks efficiency, conveyance canal efficiency, and on-farm efficiency). In theory, a perfectly designed and operated system, with only minor opportunity for evaporation or seepage, would deliver water to crops approaching the 100% level of efficiency. The reality, however, is that water losses do occur as a result of both natural and systems causes, and the SSRB Summary Report approximates efficiency in the basin, based on gross estimates of diversion, as ranging from 30% to 60%. Most estimates of irrigation efficiency are based on the assumption that irrigators apply enough water to obtain optimum yields (maximum financial return). With the trend for applying water to less than the amount required for optimal yield, it can be assumed that irrigation operators are accepting a production level which may be controlled, to some extent at least, by their limiting the immediate costs for applying water. The irrigators appear to be increasingly cost-conscious.

In considering Alberta's water resource allocation to irrigation, there are at least three efficiency concepts: (1) allocation efficiency; (2) operational efficiency; and (3) irrigation efficiency.

The first is an overall economic concept and refers to allocation of water resources among different sectors of the economy (e.g. industrial, municipal, agricultural, hydro-power generation, recreation, and other uses). At this stage of development, investment of water in irrigation agriculture is totally integrated into the economic base of the province.

The second concept, operational efficiency, is physical in nature, and refers to the efficiencies of the various facilities distributing water, including headworks, storage, and conveyance systems, to farm turn-outs or delivery gates. The measurement of the technical efficiencies would determine the degree to which the distribution systems can transport water from the diversion points to delivery points effectively and with minimum loss.

The third concept, irrigation efficiency, simply measures the proportion of the gross diversion used in irrigation farming to supplement precipitation.

The individual perceptions of what constitutes efficiency or inefficiency varies dramatically. For example, most conveyance systems in the major Irrigation Districts of Alberta are gravity supplied. In order to deliver water throughout the Districts' irrigable areas, there must be sufficient water in the systems to, in effect, drive the systems. In order to supply water at the required rate and to the extremities of the irrigated areas, there will be surplus water in the systems, which will go into return flows. Improvement of efficiency in such systems will mean keeping this return flow to a minimum, not removing it completely. While converting the conveyance systems to pipeline would save water, the cost for a large scale change, at this stage, could not be considered viable.

In attempting to improve efficiency, that is, the effective use and distribution of water diverted to the uses in question, it is important that initiatives and energies are applied to those improvements which can have a significant impact. One must go through a test which would include questions such as:

- where are the inefficiencies occurring in the system;
- what is the cause of the inefficiencies;
- is it practical to improve the efficiency levels in the identified areas;
- how much will it cost; and

- who should bear the cost of the improvements?

It is also essential that efficiency evaluations be co-ordinated to determine the relative impacts of the headworks and storage, the distribution systems in the Districts, and the on-farm factors. While the need for increasing efficiency is accepted, it is believed that there were higher expectations for water savings expressed in some inputs than is realistic. Nonetheless, the close relationship between costs in money and costs in water supports the highest practical levels for efficiency in the use of both.

It should be acknowledged that the "farmer" improvements and investments in modern sprinkler equipment during the past two decades have been the most effective step to improve irrigation efficiency. This action allowed more controlled application of water which resulted in a much reduced potential for soil water-logging and salinization, while bringing substantially greater acreages under irrigation. The Panel agrees that this move was a major step towards water use optimization.

The importance of the availability of water supply and strategic storage, which can ensure an adequate water quantity and timely delivery, must be included in the overall evaluation of efficiency. Adequate supply in the right places and at the right times has been cited as essential to systematic and optimum use of water in irrigation.

The efficiency of irrigation systems having on-stream and strategic off-stream storage was demonstrated during the 1984 and 1985 drought periods. Consistent volumes of water delivered on schedule sustained optimum growth through the extended dry and windy periods. Those systems with limited flow control and storage, or without any of these facilities, were subject to periodic shutdowns. Irrigation agriculture efficiency and effectiveness is improved with consistent supplies of water.

The major systems rehabilitation program, which is supported by the Province, is improving both the headworks and distribution systems to reduce losses and facilitate much improved delivery, both in quantity and timing, to support optimum crop growth. This public funding support to irrigation is based on wide-spread public benefits, both in the area and for Alberta as a whole, making it incumbent that efficient use of water be made so that optimum benefits to all will result. As irrigation use of water approaches the maximum quantity which can be supplied, increased monitoring throughout the systems will be essential, particularly aimed at correcting for losses of water and other inefficiencies found.

Completion of the systems' rehabilitation, including the essential measurement components, will facilitate more efficient operational management.

Since costs for further improvements will be greater, data bases must be developed which can provide management with information on which to develop cost effective measures for facility and management systems. Improvement in efficiency in both facilities and management should be a significant consideration affecting the issuing or increasing of licences, and in dealing with cost-sharing arrangements between the Province and the Irrigation Districts or irrigators.

Recommendations - Efficiency

The efficient use of Alberta's water resources means obtaining the best rate of return on the commitment of money and water in meeting the province's social and economic objectives.

The future development costs for supplying and delivering water, which is a finite quantity in the basin, will increase. At the same time, the market for products will become more competitive. It is therefore imperative that the highest practical level of efficiency in the irrigation systems and the operation of them is achieved. The following recommendations are made to assist and encourage improved efficiency and must involve both the water users themselves and government agencies at all levels.

1. It is recommended that the Province facilitate improved soil moisture monitoring and related precipitation and general weather forecasting, and broaden the distribution of this information to assist irrigators and managers with the timing and gauging of water requirements.

2. It is recommended that the rehabilitation program for the irrigation systems be completed, particularly concentrating on the correction of significant water loss causes in the systems: removing constrictions, salvaging water-logged and salinized canal-side lands, reducing land severance and increasing the capacity of the systems overall.

3. It is recommended that as irrigation use of water reaches the supply limits, more sensitive control of delivery be facilitated to improve irrigation efficiency. It will be necessary that increased measurement and monitoring of water delivery be undertaken, starting with the main diversion points and the conveyance systems junction points, to gauge and improve the delivery efficiency. This would also give more accurate information for considering further water assignments. The data base which would be developed

would provide for better identification and isolation of operational problems in the systems.

It is further recommended that the rehabilitation program fund these improved measuring and control facilities which are necessary to optimize water delivery and conservation.

4. Since the amount of water applied in irrigation to raise crops has been quite variable, it is recommended that Alberta Agriculture undertake investigative work, if necessary, and provide the irrigation operators with the best possible advice on both the productive and economic components related to water application rates. This research should explore and evaluate the effects of potential water rationing, the rotation of supply, and the relative effects on curtailment or reduction of water supply on various crop types. The information on this subject will also be important for future consideration of both licencing and assessing the potential production risks where periodic water shortages occur.

5. It is recommended that standards for operational maintenance be reassessed to ensure a level of maintenance, that will keep the systems at a high level of efficiency and prevent significant deterioration. This reassessment should be the joint responsibility of the Provincial Government and the Irrigation Districts. When completed, a consistent standard of maintenance should be adopted across all Districts. Monitoring of maintenance for compliance should be the responsibility of the Districts, with support and consultation of Alberta Agriculture and Environment.

6. It is recommended that standards be established to gauge water use efficiency and that these be used to monitor the systems.

   The standards must respect the practical limitations of management measures in order that cost effectiveness is maintained. While crop demand will be variable depending on weather and soil moisture conditions, crop variety and other factors, reasonable practice guidelines should be developed to assist the irrigator in gauging water requirements and as an information base for his use in optimizing on-farm efficiency.

   Water licences and agreements should be assessed for compliance with efficiency standards.

7. It is recommended that the agencies responsible for water use regulation, including Government departments and Irrigation Districts, be empowered to limit or reduce

licenced amounts where controllable inefficiencies are found and are not corrected as required.

Limits and Expansion of Irrigation

Most submissions to the Hearings acknowledged that food demand world-wide would be the driving force for higher production levels. With the mood in the western world, at least, for freer trade, the highest practical levels of efficiency in this production will be a major element in the producers' ability to sell. Along with the ability to produce more, it is equally important that such production be sustained so that hard-earned markets continue to be available. In supplying the range of markets available to us, there will continue to be a challenge to producers and marketers to obtain sufficient returns so that a positive net balance is achieved for the industry.

Irrigation agriculture has the facility to substantially increase production per acre, and to produce a wide variety of products, including specialty crops. It, therefore, has the attributes necessary to stabilize, intensify and diversify output on those lands that can be irrigated. These three qualities are crucial for securing and maintaining markets.

Irrigation proponents took two different positions respecting levels of risk in acreage expansion. First, there was an expression by irrigators that the target should be to maximize the number of acres, and that this should be achieved in the most productive areas to which water could be supplied at least cost. This same group, while recognizing some adverse effects which could occur in periods of serious water shortage, tended to stay with the position that increasing acreage was the best economic approach, overall.

The second position taken was that water licencing and related uses should be limited to largely eliminate the potential risk of shut-downs, as the heavy investment necessary to equip and develop irrigation requires sustained returns to keep irrigation agriculture viable.

In reviewing the South Saskatchewan River Basin relative to the records of water supply situations where shut-downs were necessary, it is evident that the significant problems have been mostly in situations where there was little or no flow control, including storage. This circumstance applies both to the main stem river systems and to the smaller tributary streams which serve agricultural areas suitable for irrigation.

A number of factors, therefore, need to be considered in dealing with the question of limitations and expansions. As a common denominator for any or all of the questions, the Panel has taken

the position that safe instream flows on all streams which become managed or from which significant diversions are made must be established as an initial base. Factors to consider are as follows:

- The protection of a minimum safe instream flow together with acceptance of a certain level of risk in supply must be the base for considering either limitation or expansion of water assignments to irrigation.

- That moratoria and/or limitations on water diversion be kept in place where lack of flow control or of supply during the diversion periods cannot safeguard the residual flows.

- The assignment of water to areas contiguous with the tributary streams must be justified on the basis of both soil and climate suitability and in consideration of the competition with serving other areas downstream.

- It is believed that the majority of the public supports agricultural diversification, higher value production, and stabilization. The Panel agrees with this position, and considers that expanding and optimizing irrigation is an essential long term investment for agriculture in the province. It was also stated, at the Hearings, that safe instream water quality for downstream users and aquatic life must be protected. The compromising of these positions, considering the current state of land use development and social desires, suggests that increased stream flow control and management is necessary and that this would include optimum and strategically sited storage to distribute the opportunities for irrigation agriculture, while being operated to protect the instream uses.

- The potentially greater variation in stream flows associated with smaller tributary basins suggests that the commitment of their water supply should be relatively less than from the larger main stem basins. It is also considered that before maximizing the licencing commitment for water withdrawals from the smaller tributary basins, even with flow control, that experience with the capability of the storage regime should first be obtained.

- The Panel considers the current phase for irrigation development should include the following three factors:

    - the currently developed irrigated acreage;

    - the additional area which can be effectively accommodated with the completion of the present rehabilitation and expansion program; and

- the commitment of the water recommended to be reserved for other areas.

The approximate total acreage for this phase is 1,600,000 acres[3]. Expansion of the irrigation acreage above this level is considered a second phase or "upper level" expansion.

The capacities of the provincial headworks and the district conveyance systems are being enlarged as they are rehabilitated under the current program. To make effective use of this investment, infilling on appropriate lands in the Irrigation Districts within economic reach of these upsized delivery systems, when completed, is a reasonable next step.

The Panel recognizes the interest of farmers in new areas, not serviceable from the expanded District systems and requiring new infrastructure and management. A reasonable quantity of water within the basin should be reserved for potential irrigation in areas north of the Red Deer River, along the South Saskatchewan River in the Medicine Hat area, on the Blood Indian Reserve, the Peigan Indian Reserve, and the Blackfoot Indian Reserve, and other areas, when needed. Investment of both water and money for such developments should be based on confirmation of suitable soils and topography, adequate heat units and frost-free growing seasons, and the willingness of local farmers to invest, and should be comparable in cost to investment in irrigation throughout the basin.

The South Saskatchewan River Basin Planning Program Summary Report set out a number of scenarios, extending from the committed Base Case[4] to maximum allocation levels. They illustrate a range of acreages which could be irrigated, the related costs, the value added to the economy of the province, and impacts on the other uses.

For example, the maximum water allocation scenario illustrated the largest irrigation acreage employing the basin's water supplies in areas which could be supplied from highly managed flows in all three rivers, but particularly oriented to water from the Bow and Oldman Rivers. This example resulted in the following estimates: 2,338,300 acres irrigated over the total basin - an increase of 898,690 acres over the presently committed expansion (Base Case). This expansion was estimated to cost $5,061,000,000 - an increase of $3,597,000,000 over the Base Case. This example also estimates the creation of jobs and value added about 60% more than the Base Case with a potential water

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[3]Base Case plus 150,000 acres (reserved water) approximately.

[4]Appendix 5

supply deficit at approximately 17% in low flow years. To some extent, this illustration would rely on a fixed contribution by each of the rivers to the Apportionment requirement of water to Saskatchewan. A fairly substantial part of the irrigated area would be in the Red Deer River basin, but largely supplied from the Bow River.

It is estimated that the time required to mobilize the increased irrigation areas, which will be accommodated with the current systems' expansions, will be of considerable length, well beyond the completion of the storage and conveyance systems construction phase.

In the Panel's view, the second or "upper level" phase of expansion is sufficiently down-the-road timewise to require reassessment of benefits and costs and the economic capabilities of the Province and the Districts, which will be current at the time the expansions are being considered. This evaluation should also include consideration of market security and the adequacy of product values which will be necessary to cover off the costs for producers on these irrigated lands.

It is also understood by the Panel that the "upper levels" of potential expansion will require an increasing rate of capital expenditure per irrigation acre for the infrastructure. The Panel estimates that the Irrigation District and the farmers' share of developmental costs will become relatively higher as facilities for the maximization of water distribution are initiated. This higher unit cost potential will require an increase in the farmers' earning power to support his commitment to the costs. The Districts' and farmers' ability to invest needs to be assured before upper level expansion investments are made. Also, some additional regional distribution of irrigation within the basin may be justified to satisfy equity between areas, and such components will also need to be included in the evaluation of benefits before proceeding with such expansion plans when they are of significant scale.

Intense interest has been expressed for irrigation from water supplies and on land associated with tributary streams (e.g. Highwood, Little Bow, Mosquito Creek, Willow Creek, and others) as attested to by the large number of applications for water rights which are held in abeyance under current moratoria. A number of towns and villages in these tributary basins have had some water supply shortages. Concern has also been expressed regarding the low flow impact on fisheries. To satisfy an optimum development of irrigation, to ensure safe instream flows for fisheries and downstream uses, and to increase the security of municipal supplies, flow control and storage in these tributary basins will be necessary. The Panel considers also that stabilizing the water supply in these areas for the many uses served would be a justifiable Provincial investment.

Recommendations - Limits and Expansion

Efficient irrigation systems and management will improve the opportunities for stability in agricultural production, intensification of land use, diversification of agricultural products, and support for value adding processing industries creating employment.

Experience has shown that there is a competitive advantage in having a production capacity which can take advantage of markets as they develop. Irrigation is a substantial long term investment to support increased and diversified production capacity.

At this stage of irrigation development, it is evident that effective use of the water as well as efficiency in the delivery and application processes must be intensified in order to maximize benefits.

1. It is recommended that the current rehabilitation program, including the expansion of the conveyance systems and the supporting on- and off-stream storage presently committed, be completed. This rehabilitation process should include strategic measurement facilities in both the headworks and district conveyance systems to provide for more efficient management of operations and data for the administration and control of the water resource.

2. It is recommended that a comprehensive review of policy supporting headworks for new irrigation areas be undertaken to clearly establish the limits covered by the province and the proportionment of operating costs where the headworks supply is power driven. The purpose for this recommendation is to confirm a common and equitable base for the consideration of new area irrigation using pump headworks, for the information of both the interested new irrigation area groups and the Government.

   Where Government supported headworks, including multi-purpose storage, are necessary and have been justified, it is the Panel's further recommendation that the irrigators to be served be required to form a legally constituted management group. Basic requirements for such an organization would be to ensure irrigation acreage supported by the headworks investment is developed and equitably distributed, and that water allocations and cost assessments are consistent among the irrigation systems users.

3. It is recommended that effective use of the expanded capacity of the supply and conveyance systems included in the rehabilitation program be facilitated by infilling of irrigation on appropriate lands in the Irrigation Districts within economic reach of the upsized delivery systems.

At the same time, it is recommended that a volume of water within the supply systems of the entire basin be reserved for "new" area irrigation of approximately 150,000 acres in areas north of the Red Deer River, along the South Saskatchewan River near Medicine Hat, and on the Blood Indian Reserve, the Peigan Indian Reserve and the Blackfoot Indian Reserve. All of the water assignment should, in priority, be to lands and in climatic zones classified as most suitable for irrigation. The reservation should be subject to a review process every five years to consider the question of increasing or decreasing the amount reserved.

4. It is recommended that detailed planning options be advanced to develop adequate storage, flow control, and the essential diversions to stabilize the supply, protect instream life, provide security for municipal supplies and support for optimum irrigation in the Highwood-Little Bow and the Willow Creek sub-basin areas.

   These streams have wide variations in flow and, because of this and their limited size, will require a higher percentage instream flow retained to protect fisheries, which are particularly important in specific reaches.[5] It must also be noted that all tributary streams have a commitment to Apportionment, and that the upstream use in the tributary area is in competition with downstream users, including those on the mainstem receiving rivers. It is, therefore, concluded that the amount of water which could be fairly diverted to irrigation in the tributary basin might be limited to about 25% to 30% of the mean annual flow. Limitations applied could be adjusted as experience on the storage regime and actual irrigation withdrawals are obtained. The storage facility should, however, be developed ultimately to the maximum amount feasible in terms of site suitability and availability of water. Notwithstanding the above proposed limitation, the Panel supports retaining the current moratoria until adequate flow control can be implemented.

5. The administration of licencing will require increasing attention as the water supply becomes committed to its optimum level. The Panel has recommended, in the section of the report dealing with allocation of water to Apportionment, that a fixed formula for contribution from each of the rivers in the South Saskatchewan River system not be set, and that water management continue on the single basin concept for this system. It is expected that increases in irrigation and regional distribution will make it necessary

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[5]Appendix 6 demonstrates the variations in flow of the Highwood River.

to have a quick-response administrative system to ensure timely and complete accounting of water committed and compliance with the terms of Apportionment. It is recommended that the licencing administration process have adequate resources to deal with this area of water management, which will become more demanding and complex as water use reaches the limits of the supply that can be maintained.

6. The current rehabilitation program will provide new efficiencies and, together with the storage facilities and conveyance systems enlargement, will provide for increased acreages of irrigation within reach of the upgraded systems. When this construction phase is completed, it is recommended that a review be made of the benefits for that portion of the work in the Districts where the costs are currently shared on the basis of the 86:14 formula. It is the view of the Panel that after these major works are completed, the benefits to the irrigator will increase. It will be important that an appropriate standard of operational maintenance be continued to keep the systems at this high level of efficiency and to prevent significant deterioration. Charges to the water user, in addition to covering the O&M costs, could be increased to reflect the benefits which accrue from the rehabilitation work, and the money paid into a revolving fund for future improvements or rehabilitation of essential parts, as may become necessary. While it is recognized that the management of funding and operations in the Districts is currently the responsibility of the Districts, it is considered prudent that steps be taken now to ensure reasonable financing for future replacement requirements.

7. The Districts and the Province should monitor the actual expansion progress of irrigation into areas in the Districts and within economic reach of the expanded or enlarged facilities to determine the effective utilization of the delivery systems and the investment made in them. Such data are essential for managing water licencing. It is also important that regular benefit-cost measurements are taken, as this information should provide a significant indicator in respect to the viability of further expansions and in defining appropriate cost sharing arrangements.

   The present rehabilitation capital works program in the Irrigation Districts provides infrastructure expansion for new acreages of irrigation. Currently, this cost is shared between the Province and the Districts on an 86:14 ratio. This investment has applied to organized district conveyance systems which are necessary to supply and distribute irrigation water to relatively large blocks of land in the Districts. While new area projects (outside of Districts)

should ideally be operated without District level conveyance systems to the largest extent possible, optimization of development in areas may need some strategic conveyance elements. To maintain comparable equality in Provincial support to new area irrigation development, a cost-sharing arrangement similar in concept or principle to the present 86:14 formula would be recommended.

In view of the substantial difference between the operating costs of power driven supply systems and gravity systems, it is necessary that cost-sharing distribution for the power driven systems be defined for reasonably consistent application to future and active projects.

8. While irrigation offers the opportunity for intensifying and diversifying agricultural production, market availability is really a prerequisite to obtaining the economic benefits and stability which can be achieved.

   The Panel recommends increased marketing initiatives for agriculture overall, including the specialized and higher valued products which can be consistently produced under irrigation. It is important that the scope of marketing initiatives recognize and assist, as appropriate, in the development of value adding industries.

9. It is recommended that "upper level" expansion viability be evaluated, including a reassessment of benefits and costs associated with the economic capabilities of the Province, the Districts, and the irrigation farmers which are current at the time such expansions are being considered. The decision to proceed, and the timing and/or the rate of implementing this expansion should be based on favourable economic projections.

Dryland Agriculture

During the severe drought seasons of 1984 and 1985, the supply of water for domestic use and stock watering was under considerable stress in areas throughout the basin. Emergency water pumping programs sponsored by the Provincial Government responded to these critical situations well. The Province also launched programs to test and develop groundwater supplies, and, with assistance from PFRA, to increase and expand the capacity of dugout storage facilities. Water sourcing for those areas where there have been repetitions of water shortages is considered by the Panel to be an important issue in developing more secure water supplies.

Recent initiatives have also been taken to evaluate and develop strategic utility systems to distribute water from sources that are secure. Examples of this activity would include the development of distribution systems from irrigation storage reservoirs, such as from Ridge Reservoir. This approach to provide better quality and secure supplies of water for both farmstead and stock watering requirements is encouraged.

As time goes by, more water users will rely on the water sources of all scales throughout the basin, including tributary streams running through both dryland and irrigation agriculture zones. Some concerns were expressed, at the Hearings, on the potential for stream pollution from adjacent farming and stock feeding operations. It appears that adequate regulations are in force to control such developments, including conditions for location and control of waste flows. It is obvious, however, that the potential for pollution will increase, with more concentrated agricultural practices coming in contact with increased numbers of users.

Recommendations

1. The Provincial Government should continue to support programs which provide greater stability for on-farm water supplies, including both those which develop water sources and those which increase storage capacity to sustain the supply for longer periods.

2. Distribution systems to serve groups of farmsteads from either developed or natural water sources should be eligible for an appropriate level of Provincial assistance.

3. Adequate pollution control must be maintained to safeguard water supplies which may be affected by runoff or by waste drainage, such as from feedlot or dairy operations. This applies to all agricultural activities, whether they are located in dryland or irrigation areas.

Industrial Use

The four major issues relating to industrial use of water in the SSRB are: the importance of water to economic development, the need for secure water supplies, the impact of industry on local supplies, and the effects of industry on water quality.

It is the Government's policy to encourage balanced economic growth throughout the province; diversifying the economy, making it less dependent on the sale of unprocessed resources, and strengthening small and locally-controlled businesses. Agriculture is the economic base in much of the SSRB, and many presenters viewed secondary agricultural industry as necessary to ensure that more of the benefits of agriculture remain in the region and in the province. Several communities requested that their supplies of water be assured or improved to assist them in attracting and developing industry. Agriculture has already created industrial opportunities in the basin (such as food processing and alfalfa dehydration for export), but improved water supplies may be needed to take advantage of other opportunities in rural areas. As a general principle, where industry is economically feasible water should not be allowed to be a constraint, within the limits of practical supply. Normally, this water should be provided through municipal systems to benefit both domestic and industrial users.

Assured supplies of water are important to industrial operations. Most industrial activity occurs in or near municipal centres and, typically, industry's water is supplied by municipal systems. By assisting municipalities in water supply and effluent treatment, the Province indirectly assists those industries. Industry is also aided in the SSRB by the control of river flows (the benefits of the Dickson dam were cited by industry at the Hearings). Oil industry spokesmen at the Hearings were, however, concerned for the future, and requested better flow maintenance before more water is allocated. They also contended that water should be available to industry at reasonable cost; that industry should not be required to provide its own off-stream storage. It is Government policy, however, not to directly subsidize industry for water management. The Panel agrees with this policy, but supports the continued consideration of industry's needs when regulating river flows on managed streams and when licencing withdrawals.

Industry accounts for only a small portion of the consumptive water use in the SSRB (about 1%), but industry can withdraw and consume significant amounts of water relative to local tributary flows. Moreover, industrial needs remain constant, while tributary flows often vary widely throughout the year, which can exaggerate any imbalance. Basin water planning must consider the potential for significant impact of industry on tributary

streams, not just on the mainstem rivers or on the overall basin water balance.

To reduce or avoid water use conflicts while still allowing for oil and gas industry needs, their spokesmen suggested that these water needs should be documented and forecasted. Consultation between the industry and Alberta Environment and, when applicable, the Irrigation Districts could also help reduce other potential problems, including land use conflicts. For example, though some industries have gained advantage from the use of water from irrigation canals or from communities supplied by them, rehabilitation and further development of irrigation could interfere with existing or future access to oil, gas and coal reserves, or require changes in pipeline systems. Co-operative planning could help reduce or avoid such problems.

Concern was expressed at the Hearings regarding the possible impact of industry on local groundwater supplies. Some people felt that groundwater should not be used for industrial projects, such as waterflood injections. Surface water, rather than groundwater, is normally used for large operations because few aquifers in the basin contain sufficient water of acceptable quality for this use. Most small and medium-sized waterfloods rely on groundwater and the total water volume allocated for this use has been increasing exponentially, although actual consumption has remained relatively constant in recent years. It was claimed at the Hearings that some losses of domestic wells have occurred as a result of oil industry activity. Such losses may be considered inconsequential to the overall basin water supply, but they are very serious to the people affected. So too would be the effective loss of a well through groundwater pollution. Industries should only use groundwater in cases where it is abundant and clearly in excess of other local needs. Though multi-purpose use should be allowed where practical, existing and future domestic and agricultural groundwater users must be protected. Special care must be taken by industry to ensure that groundwater is not polluted because of the importance of this resource and the very long time required for it to be naturally cleansed. This situation is discussed in more detail in a later section on 'Groundwater'.

Industry can affect water quality in a variety of ways, from increasing sediment loads or water temperature to releasing chemicals. Several presenters asserted that industry must return clean water: that reliance on assimilation is not an acceptable substitute and that there is no assimilation of certain substances, only dilution. Industrial water pollution is not presently acute in the SSRB, but industrial processes use and produce an ever increasing number of substances which, if not properly identified and handled, could seriously harm water quality. Knowledge of their effects on the health of humans and on the environment is important from both a basin and a provin-

cial perspective. We must have the ability to economically and effectively monitor this situation; a task which should receive high priority. Close co-operation between industry and government is necessary, as is thorough monitoring by both. For this effort to be effective and efficient requires clear understanding of which substances pose health threats and how they can be safely controlled. General water quality issues and recommendations, aside from this particular concern regarding industry, are considered in a following section.

Recommendations

1. The Panel recognizes the needs of industry for water and the wishes of residents of the SSRB, particularly rural residents, to develop and attract more secondary industry. These needs should be addressed largely through continued support for municipal systems for developed and serviced industrial land.

2. Industry should not be directly subsidized for water management, but industrial needs should be considered when establishing and allocating flows. Industry, in conjunction with Alberta Environment, should develop projections of industry's water needs throughout the basin. This process could simultaneously be used to avoid land use conflicts.

3. Industry should only use groundwater when it is abundant and clearly in excess of present and projected local domestic and agricultural needs. The impact of industry on local groundwater yield and lowering of head should be monitored. Where problems currently exist the operator's licence should be reviewed. Special care must be taken by all industries not to pollute groundwater.

4. Industry should be prevented from releasing potentially hazardous substances into water systems, and should be responsible for the safe confinement, removal and disposal of such substances. On-going research is required to identify hazardous substances, to consider their effects in combination as well as singly, and to select or develop disposal techniques. Though Government must remain the ultimate arbiter, industry should be primarily responsible for this research.

5. Monitoring of both water quality and industrial operations should be done on a regular basis, or continually if necessary, to ensure that water quality is protected. Industry should continue to be responsible for this monitoring.

6. The Provincial Government must maintain high standards of in-house expertise and vigilance to ensure it can and does adequately assess the research and monitoring done by industry.

Hydro-electric Power Generation

Two major issues relating to hydro-electric generation in the SSRB are discussed here: the importance of hydro power to the Alberta electric system, and the effects of hydro reservoirs and their operation on other users. Only those effects specifically related to the operation of hydro reservoirs are included; general impacts of these and other reservoirs are considered in 'Storage'.

Importance

Hydro-electricity is important to the Alberta power system. Though it comprises only 6% of the total generating capacity of Alberta utilities, hydro provides peaking power and an emergency back-up. According to utility and power representations, these functions are important to the Alberta Integrated System, helping to ensure that it is reliable and responsive to demand change, and helping to minimize costs. These presenters indicated that this role should be maintained, although the percent contribution by hydro will decline as the system increases its capacity. Altering the system by reducing the capacity and flexibility of the hydro component would incur costs by substituting thermal power. It was estimated that peak power replacement costs would be substantial over an extended period of time and that, if such changes are required in the operation of the Bow River system, compensation would be justified so utility customers would not be penalized. Some presenters also opposed changes because of concern about increased pollution from thermal power plants.

Several presenters advocated taking the opportunity to install hydro power capability in any new irrigation dam in the SSRB. They intended to make electricity cheaper and to provide additional income, which would improve the cost/benefit ratio of on-stream storage. This suggestion must, however, be considered carefully in light of the effects hydro operations have on other uses, particularly irrigators themselves, who need water released at times conflicting with hydro use.

Effects on Other Users

The most important factor determining the effect of hydro generation on other users is the associated pattern of water storage and release. Reservoirs are filled through the summer to accommodate power needs that are heaviest in winter. Daily fluctuations in releases parallel consumer demands, peaking in early evening. These alterations of flows change the rivers and are detrimental to some users, but the hydro system also provides benefits to others.

The Bow River hydro system provides some flood control and augments winter flows, which helps reduce pollution effects by

increasing assimilative capacity. The Bearspaw dam functions primarily to re-regulate flows, smoothing fluctuations and controlling ice development. Its reservoir is the municipal water source for a large part of Calgary.

Hydro reservoirs are used for recreation, though the unpredictable fluctuations in reservoir levels and downstream flows characteristic of hydro operations limit their use compared to stable storage reservoirs and operating regimes. TransAlta Utilities, however, releases water to accommodate specific recreation events. Other factors, including rugged topography, water temperature, climate, access and land ownership also impact recreation use of hydro reservoirs.

The extreme fluctuations in releases from hydro dams can have a detrimental effect on downstream fish habitat, as the scouring and high flow rates associated with rapid, large releases remove the gravel, vegetation and food required by fish. These effects can be mitigated either by installing dams to re-regulate the flow, such as has been accomplished by the Bearspaw Dam, or by altering the operating regime.

There is a fundamental conflict between irrigation and hydro use of rivers because their needs for water releases are greatest at opposite times of the year: irrigation demand is greatest in the summer when hydro operators need to fill their reservoirs. TransAlta noted that they adjust their operation within limits to benefit irrigators, releasing water to ensure flows are held at "natural levels" in the spring and fall, which, they advised, reduces water available for hydro power generation in the winter. One Irrigation District noted at the Hearings that the power company's management of the Bow River reservoirs is a good example of co-operation that benefits both the industry and irrigators. Other presenters, including the AIPA, saw this storage as more valuable for irrigation because there are alternatives for power production, which might prove cheaper than building new irrigation storage. These people advocated managing the existing Bow reservoirs to benefit irrigation more than power generation. The power dams were not, however, designed for this role, as their spillways are inadequate to be operated effectively for irrigation. Also, winter releases for power generation provide other benefits, such as increasing the capacity for effluent assimilation and contributing to Alberta's required contribution to Apportionment. TransAlta also suggested that its new Calgary control centre could be used to provide co-ordinated control of all Bow River reservoirs to everyone's benefit.

Recommendations

The following are recommendations specifically regarding the use of hydro reservoirs:

1. Since hydro generation is a flexible and valuable source of power and since existing hydro dams were neither located nor designed to supply irrigation, their present use should be retained. TransAlta is, however, urged to continue co-operating with irrigators, as much as possible, by releasing water during the irrigation season, particularly in low flow situations.

   Beyond this, if more storage is needed on the Bow River for irrigation use, it should be located and designed for that purpose.

2. Sharp fluctuations in releases from hydro dams should be minimized, whenever it is reasonable to do so, during periods critical to fish reproduction and intensive downstream recreational use.

3. Mitigation measures, to enhance fish habitat below hydro dams, should be implemented in reaches where they could have a beneficial effect, without seriously impairing hydro production.

4. Operators of hydro reservoirs should continue and improve communications with communities and users, both downstream and on reservoirs, regarding the timing of releases and reservoir level fluctuations.

5. TransAlta's suggestion that its Calgary control centre could be used to manage all reservoirs associated with the Bow River should be considered. It is possible that this could provide the best integrated control of the river to the benefit of all users.

Groundwater

The most visible water bodies are rivers, streams, and lakes, but groundwater is also a very important resource in the SSRB. Groundwater is the only readily available supply for domestic water in much of the basin. It is generally more independent of weather than is surface water, with little variation by season. Prolonged dry conditions and decreased recharge rates, combined with increased consumption, eventually reduce supplies. Groundwater in Alberta is, however, a renewable resource, though the rate of recharge can be low, and high yields of high quality groundwater can be difficult to find in southern areas. Increasing populations and corresponding domestic consumption, along with other increasing uses, are placing greater demands on this resource. Most recently, this has coincided with drought conditions, which have reduced recharge rates. Several presenters at the Hearings stressed the value of groundwater to them. Issues raised related primarily to groundwater supply and quality problems experienced by these people, and to existing and potential conflicts between industrial and domestic uses of groundwater.

Groundwater supply problems were reported by several communities and rural users at the Hearings. Supplies were claimed to be low and, in some cases, declining in the Special Areas, in the Little Bow and Willow Creek basins, in areas north of Calgary, and near Foremost; though exceptions were noted because of the highly localized nature of groundwater conditions. A few communities have already found it necessary to change to surface water sources, in spite of the considerable expense. Others are anticipating the need for such measures or for drilling wells deeper or further afield. Emergency pipelines were used to supply communities that experienced water shortages during the recent drought, and emergency well drilling assistance proved necessary for some communities and rural residents. Solutions to augment or replace groundwater supplies are usually expensive and may be beyond the means of the individuals or communities affected; they can also be hard to justify when they are not needed in all years.

At the Hearings, both demand and supply were cited as causes of groundwater shortages. In general, the population of the basin is increasing and the effect of this on consumption has been compounded by changing lifestyles and expectations, which have resulted in greater per capita demand, particularly in rural areas. Groundwater supply problems have also occurred in places experiencing no growth, or even population decrease. Most of these apparent supply declines occurred during the recent dry years. One claim was heard, however, that a local water table has apparently been declining since the 1950's. Since information regarding the volume of each aquifer is difficult and expensive to obtain, there is much conjecture among users about both the amount of and the changes in the supply.

Like quantity, groundwater quality is highly variable by location and depth, and presents problems for finding dependable supplies of potable water. In several instances in the SSRB, groundwater is effectively unavailable because of its quality, with high concentrations of various salts being the most common problem. In some communities, groundwater supplies do not meet the Canadian Drinking Water Guidelines, cannot be consumed by people on restricted diets or by livestock, and cannot be used for irrigation or lawn watering. Yet this water is still relied on for the towns' domestic supplies. Many residents of rural areas and small communities have tolerated such conditions in the past. Understandably, they now desire and expect to have better quality water, more comparable to that of the rest of the population.

The majority of groundwater quality problems in the basin are natural, but there is risk of pollution from several sources, including seepage of agricultural chemicals and from septic systems, landfill sites and industrial disposal. This risk is potentially very serious because potable groundwater supplies are a necessity to many people. Moreover, groundwater pollution can take a long time to become evident, and, once polluted, groundwater is naturally cleansed very slowly, if at all. All efforts should be made to ensure that potable groundwater is not contaminated. Alberta Environment's recently initiated program to monitor trends in groundwater quality is a welcome contribution to this end.

Though surface and groundwater are distinctly different water resources, they are not independent. The groundwater in most of Alberta is not in isolated aquifers, but is in contact with surface water, is recharged by it, and, in turn, recharges surface bodies during low flow periods. This has implications for water management. The primary advantage is that the SSRB's groundwater is renewable and can be managed so that use will not permanently deplete the resource. Management of wetlands must consider the effects on groundwater: some wetlands are recharge areas, and drainage could lead to depletion of local groundwater supplies. Pollution of surface water or of soil in recharge areas could also lead to pollution of groundwater.

The issue of industrial use of groundwater was the subject of some comment at the Hearings. A few presenters claimed that industrial activities (notably waterflood injection for oil recovery) have interfered with groundwater use by lowering water tables and by collapsing wells via seismic activity. Generally, however, presenters directed their attention to the principle of groundwater use by industry, especially for waterflood injections. Most of those who commented on groundwater felt that potable groundwater is too precious to permit industrial use in most instances: its use should either be reserved for domestic and municipal uses and for stockwatering, or else

meeting these needs should be assured before groundwater can be used by industry. Industry spokesmen, on the other hand, claimed that they use relatively little groundwater, and prefer to use surface water when available, as they too experience problems with the quality of much of the basin's groundwater. The possibility of conflict between industry and other users depends on site-specific conditions, such as the available supply, the recharge rate and area, the water quality, and the volume needed by all users. The question of industrial use should be decided on the basis of these site-specific conditions, recognizing that groundwater is critical to long term domestic use, especially following prolonged dry periods when low recharge rates could affect the supply.

Groundwater is difficult to manage because it is a hidden resource and because conditions are highly variable by location. For these reasons, it is also difficult for the public to see that groundwater is being managed. Alberta Environment feels that their groundwater data base for the SSRB is generally good, but stress the need for site-specific information for each case. Such information should include current conditions, extent and interrelations of aquifers, flow rates, recharge rates and areas, depletion effects or likely effects of groundwater use, and the area affected. This information should be considered in the decision to grant groundwater licences for industry, feedlots and other non-domestic uses. Monitoring and reporting requirements should be part of licence conditions. Groundwater quality must also be monitored to determine natural conditions and trends, and the effect of human activities. Alberta Environment has started systematic sampling of groundwater quality to this end, but it will take several years to determine trends. Groundwater monitoring is difficult, in part, because of the manpower, time and expense involved. Licenced (i.e. non-domestic) users can be required to monitor their wells to assist in this, but the vast majority of wells in the basin are domestic. Some domestic wells should be included in a monitoring system in problem areas and where domestic uses include watering large numbers of livestock.

Recommendations

1. The overriding principle of groundwater management in the SSRB should be protection of adequate supplies of potable water for present and anticipated domestic use, especially for extreme conditions, such as the series of dry years that periodically occur in Alberta. Accordingly, protection of demonstrated domestic needs must be assured when licence applications are being reviewed.

   Groundwater aquifers should not be mined. Quantities withdrawn from confined aquifers, by single or multiple users, should be controlled so that the head is stabilized

above the upper surface of the aquifer. Water from recharge should only be committed for use when the recharge increases the head above the stable level. Unconfined aquifers, which in the SSRB tend to be recharged more locally and to be susceptible to drawdown during drought, should be subject to relatively greater monitoring than confined aquifers and to more stringent use limitations.

2. Where groundwater supplies for domestic use are inadequate or of unacceptable quality, it should be determined whether the problem is temporary or permanent. Government support, similar to assistance in providing water supply, should apply to water quality improvements when other alternatives are not realistic.

3. Where rural residents outside of communities suffer from shortages of acceptable domestic water, consideration should be made of providing central storage and supply systems to meet their needs.

4. Alberta Environment should continue to improve monitoring of groundwater supplies and quality, and of their corresponding trends, including flow and recharge rates. All groundwater licences, including new and existing feedlots or any other large-scale agricultural user, should require monitoring to assist in this regard. Efforts should be focused on problem areas and on attempting to predict problems before emergencies arise.

5. All efforts should be made to ensure that groundwater is not polluted.

6. Significant groundwater recharge areas should be protected from uses or activities that impair this function. More research should be done on the impact on aquifers of various land uses and alterations in recharge areas.

7. Potential groundwater impacts should be key considerations prior to implementation of any large scale water management project that could affect the resource, directly (e.g. the use of aquifers to store surface water) or indirectly (e.g. drainage).

WATER QUALITY

Background

At present, water quality in the SSRB is generally good, but it is variable in both time and place. Groundwater quality differs by location and depth, depending on the nature of the aquifer involved. The rivers of the basin change in character and water quality between the mountains and the prairies, below badlands and muskeg areas, and between areas of different bedrock and soil conditions. The rivers also change as a result of spring floods, low winter flows, storms, summer heat and plant growth. Factors affected include sediment loads, organic matter, heavy metals, nutrients, dissolved oxygen, salts, and temperature. In addition, these characteristics and other chemical parameters are modified by human activities via point sources of pollution, such as cities and industries, and dispersed sources, such as run-off from farms and clear-cut areas.

Water quality was one of the most frequently commented on topics at the Hearings, with over half of the presentations discussing it. The majority asked that water quality be maintained or improved; in particular, that good drinking water be made available or that existing supplies be protected. Good quality water was also considered essential for recreation, fish and wildlife habitat, and livestock, and to prevent excessive growth of aquatic plants. Algae blooms and weeds can compound the effects of poor water quality and result in increased work and expenses for municipalities, irrigators, and industry. Maintenance of high water quality was advocated as prudent planning for the future, guaranteeing long term benefits while avoiding costs. Several presenters stated that their top priority for water was not a particular use, but was assurance of high quality.

The water quality issues raised in the Summary Report and the Public Hearings related to present and anticipated problems and to ways of dealing with or avoiding them. The five main issues were:

- quality effects on uses,
- guidelines and standards,
- effectiveness of monitoring and enforcement,
- assimilation vs. treatment at source,and
- effluent irrigation.

Quality Effects on Uses

Presenters at the Hearings indicated several concerns regarding current or potential effects of impaired quality on the use of water. These included the potential for health problems; the cost of water treatment; the safety of water contact recreation; and the effects of excessive growth of weeds and algae on taste, aesthetics, fisheries and use by municipalities, irrigators, and industry. Some concerns were also expressed regarding the safety of self-treated domestic water. Though the situations cited were generally isolated in time and/or location, water quality was seen as a central concern because of its importance to the quality of life in the basin.

Presenters flagged these issues as ones requiring constant vigilance to prevent escalation of problems as populations increase. They included comments that monitoring of all discharges which reach water supplies, directly or indirectly, should be undertaken to provide data on any accumulation of deleterious chemicals such as heavy metals, salts, and organic compounds, and on trends. They recommended that sufficient steps be taken to ensure that quality would not be a limiting factor for water use and development in the SSRB.

Guidelines and Standards

The system of ensuring water quality in Alberta is based on guidelines and standards. Guidelines, such as the Alberta Surface Water Quality Objectives and the Canadian Drinking Water Guidelines define desirable levels of water quality that will protect public health and permit all uses. Alberta protects its surface water quality by effluent standards. Waste treatment standards are based on the use of the "best practical technology" until the assimilative capacity of the water body is reached, when the "best available technology" is required. The Prairie Provinces Water Board (PPWB) is considering site-specific water quality targets at provincial borders for each river.

Several members of the public recognized the problem of natural variations in background water quality; variations that can themselves exceed guidelines. They concluded that relevant standards should be set on a reach by reach basis, considering natural conditions and the principal uses of the reach and downstream, a view shared by Alberta Environment. A few presenters wanted guidelines, or objectives, for rivers and for drinking water quality replaced by enforced water quality standards.

Water quality criteria need to be reviewed periodically to evaluate improvements in the detection and analysis of hazardous materials, and the impacts of new substances. If criteria are

exceeded, it is also important to consider for how long and to what degree to determine if meaningful impacts have occurred.

Effectiveness of Monitoring and Enforcement

Both river and effluent quality are monitored by Alberta Environment. The major rivers of the SSRB are monitored monthly at one or two sites, while the Bow, Oldman, Red Deer and South Saskatchewan Rivers are also examined continuously at one site each by remote monitoring of temperature, dissolved oxygen, pH and conductivity. Intensive river surveys are done on a rotational basis for each of the three major sub-basins. Licences for effluent discharges specify self-monitoring requirements, the results of which are reviewed by Alberta Environment, supported by spot checks and general environmental monitoring. Public complaints assist in detecting violations of licence conditions. When a contravention occurs, the response depends on its severity, on its impact on health and the environment, and on its frequency and duration, with prosecution as warranted. All responses but those in the lowest category of impact are accompanied by press releases.

Alberta Environment considers its monitoring and enforcement program to be adequate and generally effective, including for detection of trace organics. Some presenters expressed concerns that monitoring was neither frequent nor extensive enough; that specific types of pollutants (notably organics and metals) and infrequent events (e.g. spills) were being missed; and that specific sources of pollution could not be found in some instances with the present system. Others simply called for stricter enforcement of regulations. In general, there was more concern for ensuring the monitoring and enforcement of pollution standards is effective than there was for altering existing standards.

Assimilation vs. Treatment at Source

It is common practice throughout the world to rely on the ability of a body of water to assimilate effluent as part of wastes disposal systems. Alberta Environment feels that the Province can continue to use the "assimilative capacity" of our rivers to deal with treated wastes. They note, however, that this use may be in competition with other uses of the rivers; it is, in effect, a consumptive use.

Some opinions expressed at the Hearings stated that the assimilation of wastes was impinging excessively on other uses, and that it is not presently taking place effectively and can not be relied on. Some suggested that there is no assimilative capacity for certain pollutants; they are simply diluted or accumulate in sediments. Some things that can be assimilated, such as

nutrients that increase weed and algae growth, were seen as undesirable. Adequate treatment of wastes at their source was advocated instead of reliance on assimilation.

Low flows were cited as a factor contributing to poor water quality, exaggerating the effects of pollution, and affecting domestic supplies, recreation, fish and wildlife, and aesthetics. Irrigation withdrawals were blamed by several people for contributing to the pollution of rivers by reducing flows. There was widespread support for ensuring that reasonable flows are retained in rivers so that safe assimilation can occur. Some advocated development of more storage to manage flows and to ensure efficient assimilation of pollutants.

Effluent Irrigation as a Disposal Option

Effluent irrigation has been used in Alberta since the late 1960's. There are currently 25 sewage effluent and ten industrial waste water irrigation systems in the province. To date, they appear to be working well. Proposals have been made to dispose of Calgary's wastes by effluent irrigation or other land disposal to avoid the largest point source of pollution in the SSRB. Some studies indicate that a complete system for Calgary may be prohibitively expensive because of the amount of winter storage and irrigable land required. A partial system may be more appropriate for Calgary.

Effluent irrigation was seen as a panacea by many of the public. It was put forward as a solution to many pressing problems in the basin; one that will reduce pollution loads (particularly below Calgary) while providing water and fertilizer for expanded irrigation. It was seen as preferable to dilution of wastes in rivers. Though there were concerns regarding its cost, several presenters felt effluent irrigation or other land disposal should be considered for funding by the Province and that major centres should be eligible for such assistance.

Some members of the public were worried that effluent irrigation could cause more problems or relocate old ones. A few wanted assurance that effluent will not find its way into rural drinking supplies. The main concern expressed, however, related to the long term effects of effluent irrigation on soil and groundwater. Several presenters cautioned against its use until studies show that it is safe and there are no accumulations of toxic wastes or heavy metals. A ten year study of Taber's effluent irrigation system has shown no significant changes to soil or groundwater while crop yields have increased greatly. Though there are possible problems, effluent irrigation appears to be a wastes management technique with reasonable potential for application in the basin. At the same time, it must be acknow-

ledged that effluents not returned to the river result in reduced flows for other uses, including existing irrigation diversions.

Recommendations

1. Safe drinking water supplies should be available to all residents of the basin. In this regard the Government should take or maintain several initiatives:

   - o determine locations which have inferior supplies;
   - o continue to fund municipalities to assist them in providing water to residents;
   - o provide information on treatment and water quality to rural residents who supply their own drinking water and consider whether further assistance might be appropriate.

2. On-going research is needed into hazardous substances that might adversely affect water quality. The primary responsibility for this research should rest with those industries which produce, sell or use potentially hazardous substances. Their effects, alone and in combinations, should be evaluated. Both the acute and long term effects on human health and the environment should be considered by the Government in order to select appropriate, safe water quality criteria for Alberta conditions.

   These criteria should be reviewed periodically, considering new information and the effects of new substances, and as technological advances improve the ability to detect, neutralize or remove hazardous substances.

3. Water quality objectives should be established for each reach. They should be based on the natural water quality in the reach, on its assimilative capacity, and on the uses of the water in the reach and downstream. Consideration should also be given to the effects of variations in flows, both natural and man-made. Effluent standards and instream flow requirements should then be established to attain these water quality objectives.

4. Water quality monitoring is necessary to ensure that effluent standards and water quality objectives are being achieved. The frequency of monitoring needed should be determined by considering the contaminants of concern and the location and uses involved. Effluent monitoring should continue to be the responsibility of the licence holder, with review and sampling by the Government.

5. The Government must remain the ultimate arbiter of water quality, and of the prescribed research and monitoring. In order to be effective in this the Government must maintain high standards of in-house expertise and vigilance.

6. Efforts by both Government and industry should be concentrated on substances most likely to be dangerous and on potential problem areas. First attention should be applied to surface waters and groundwater near the larger cities, industrialized areas, and areas important for municipal intakes or water contact recreation.

7. Instream flow requirements should be high enough to provide a surplus capacity for assimilation and dilution of pollutants to act as a buffer to cope with unanticipated events or water quality impairments.

8. The pollution effects of the following dispersed sources and land management techniques should be monitored and assessed: agricultural chemicals, soil management, irrigation return flows, drainage, feedlots and livestock management, logging and other land clearing. Standards and mitigation procedures should be reviewed and revised as appropriate.

9. Groundwater pollution can take a long time to become evident, and, once polluted, groundwater is naturally cleansed very slowly. All efforts should be made to ensure that groundwater is not polluted.

10. Alternatives to assimilation of municipal and industrial wastes should be investigated. In particular, further treatment (tertiary) and effluent irrigation options should be considered. When alternate methods are feasible from all but the perspective of funding programs, Provincial Government support should be considered, since such alternatives could extend water use by improving instream quality.

11. Alberta Environment should continue and expand its program of public awareness and education regarding water quality, including public access to water quality information. Improved dialogue could provide the Department with additional information regarding problem sites and would help to allay public concerns through a better understanding of the situations encountered.

INSTREAM FLOW NEEDS

The waters of the South Saskatchewan River Basin are central to the quality of life of the basin's residents. These waters provide for domestic consumption, waste assimilation, irrigation, industrial needs, habitat and recreational uses and hydro-electric power generation. The objectives of determining and establishing appropriate instream flows are to ensure that there is enough water left in the rivers to optimize multi-purpose use, to provide security for instream and downstream requirements including acceptable water quality, and to contribute to instream use economics; all of which are important to the quality of life in the basin. Instream flow standards are not intended to return streams to pristine, pre-development conditions nor to prevent future development.

Instream flows received a lot of attention during the Hearings, with at least 100 presentations referring directly to the need to maintain adequate flow levels. Public perception of the needs centered on ensuring a supply of water for domestic use, water quality, and fish and wildlife habitat. Recreation, irrigation, industrial and other uses of streams were also cited as important reasons for maintaining flows. Both regulated and unregulated basins were of concern regarding instream flows. In the regulated basins, such as the Bow below Bassano and the St. Mary, concerns were expressed that not enough water is being released, especially in low flow years, to meet downstream needs. For systems that do not have any storage, such as the Highwood River, the concerns were that meeting the irrigation withdrawals does not leave enough water to ensure suitable quality for fish and other needs.

On average, the stream flows in the SSRB are generally good, and are adequate to meet most needs. The drought conditions of the last two years have, however, affected agriculture and also highlighted the vulnerability of the entire basin to natural phenomena and the importance of maintaining adequate flows.

The future prospects are for increasing demands on the water supply to meet increasing municipal, irrigation and industrial consumption, as well as recreation needs of a growing population. At the same time, the potential exists that the rivers will receive more treated effluents to assimilate from municipalities and industries. Should agricultural practice employ increasing amounts of chemicals, the rivers could receive more residues through runoff and drainage systems. Setting appropriate instream flows now will help in reducing future conflicts.

Instream flow requirements are a compilation of specific needs: downstream uses, assimilative capacity to ensure water quality, instream flow needs (IFN) for fish, recreation uses, and the requirements for special flows, such as for ice control.

Instream flow amounts should also include an allowance for future water oriented development and population growth in the basin. Since the uses for instream flows vary with locations, the flow levels should be established on an individual reach basis, considering the potential uses, the relative importance of the varying needs in each reach, and the importance of the reach as an integral part of the entire watershed.

Determining the requirements for many of the instream flow uses will be complex and time consuming. It is, therefore, important that the action first be directed to streams which are already licenced for withdrawals near the stream's capacity (e.g. those for which a moratorium on licencing is in place) and to streams for which control structures are in the design or construction phase. In the latter cases, the dedication of storage capacity to meet instream flow needs should be included. For all other streams with diversion or control structures, withdrawals should be limited to the percentages of mean monthly flows that leave adequate amounts to meet other recognized uses. Identification of the necessary amounts should be based on the expertise and practical judgement of staff from the departments involved. Such situations should be monitored and open to timely reassessment as conditions warrant.

The upper tributaries and reaches of the mainstem rivers carry the mountain runoff, which provides 75% of the annual flow of the South Saskatchewan River. Individually their flows are small and often erratic, but accumulatively the water in these tributaries is especially important for meeting the downstream needs of municipalities, irrigators and other users. Instream flow requirements for upper tributaries, such as Stimpson and Pekisko Creeks, the Highwood and Sheep Rivers, and Mosquito and Willow Creeks, must respect the fact that they are the headwaters for the mainstem rivers. Many of these mountain tributaries are also the spawning areas for trout and mountain whitefish which spend part of their lives in the more heavily fished reaches of the major rivers. For these reasons, instream flow requirements for such streams are likely to be higher on a percentage basis than for those lower in the system.

Instream flow requirements should be updated as flow situations change. Such changes could result from implementation of irrigation expansion and rehabilitation, municipal conservation measures, population growth or decline, and changing demand patterns. Change in stream regulation will also require a reassessment of downstream flows. In general, since no storage is available to supplement flows, unregulated streams with diversions require a larger percentage of their average monthly natural flows committed for instream needs in order to protect these needs during low flow years. Strategic measurement of stream flow is an important tool both in determining appropriate instream flows and in assessing the success of particular

standards. As water demand approaches supply levels, increasing both the number of gauging stations and the frequency of readings taken will provide more information, thus allowing more precise management to optimize the water available for each user.

The levels determined to meet instream needs, and to provide for multi-purpose use of water, should be the basis for the operating guidelines for storage, diversion and withdrawal management. There will be occasions, however, during extreme low flow years, when meeting these standards would be difficult or impossible. For these instances minimum flows must also be established. Minimum flow amounts would provide sufficient water to ensure domestic supplies downstream, to protect quality to the minimum safe standard for human consumption, and to prevent extensive kills to fish and aquatic life in those reaches where such uses are rated as necessary. Reduction of flow to these minimum levels is only expected to be necessary during periods of severe low flow and then only for brief duration. When such conditions do occur storage and diversion facilities should be operated so that these minimum flows have priority over all other uses.

The process of protecting these flows for the various users is fundamental to water management in the basin.

Recommendations

The Panel views the establishment of instream and minimum flows as a necessary and fundamental component of the development of water management plans in the basin and recommends the following:

1. Establish instream flow amounts for all major river reaches and tributaries in the basin. Minimum flow amounts should also be set for extreme low flow conditions. Realistic flows should be set on a reach by reach basis after assessing the value of the reach for fulfilling multi-purpose uses both there and downstream. Setting instream flows is not an attempt to return to pristine conditions, but is a method of maintaining natural resources for present and future uses, while optimizing economic and social benefits.

   First priority in establishment of these flow amounts should be given to reaches where flows are currently thought to be critical (where moratoria exist) and/or where storage or diversion works are in the planning phase. Such areas would include the Oldman River downstream of the Oldman River dam, the Highwood-Little Bow Rivers, and Willow, Mosquito, Stimpson and Pekisko Creeks.

2. The portion of instream flow amounts associated with meeting municipal and industrial needs should include both a credit for the amount of water which would be returned to the river and consideration of the impact of the quality of that

water. Both municipalities and industries should be actively involved in assessing their current and projected needs with regard to amount, timing and quality of supply and return flows.

3. The portion of instream flow amounts associated with water quality assurance should provide an excess of assimilative capacity as a buffer to cope with unanticipated events.

4. For uncontrolled streams, diversions should be limited to retain instream flow amounts high enough, as a percentage of mean monthly flow, to protect the instream needs in lower than average years. Smaller streams will have to have a proportionately higher percentage retained.

5. For streams which are controlled or have significant withdrawals, minimum flow amounts should be established for extreme conditions to retain water for domestic consumption and basic water quality, as well as to prevent extensive fish kills in reaches deemed important for fish. Instream flow standards should only be reduced to these minimum flow levels for short periods during times of extremely low flow resulting from climatic conditions.

6. Until such time as the required instream and minimum flows can be established, rivers with flow control or from which significant withdrawals are made, should be managed so as to retain a reasonable portion of the mean monthly flows within the system. This portion will vary depending on the uses for the instream waters, the amount of regulation on the stream and the location in the watershed. A consultative approach among departments with responsibility for water management and/or user needs should be used in establishing these flows.

7. It may be necessary to set instream and minimum flow amounts on a monthly basis, with provision made for passing flushing flows or small peaks for spawning fish attraction.

8. Instream flows should be updated as needs change, technology advances, and after any substantial changes to stream flow conditions. They should also be reviewed as increased stream gauging makes more information available as to actual flow rates at different times and in different conditions.

9. A portion of the annual flow that is available for consumption after meeting existing and anticipated instream flow needs should be reserved, unlicensed, for future growth and development needs.

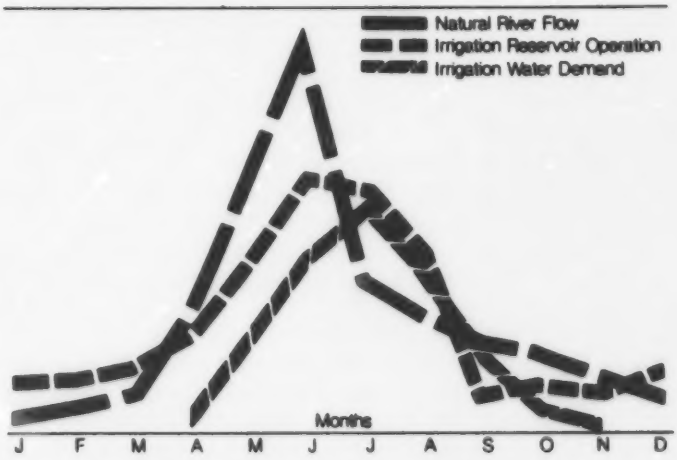
10. It is recommended that Alberta Environment lead the on-going research determining instream flow needs for the various

uses of the waters of the SSRB. All other government departments concerned with flow needs should actively support and contribute to both the research and the establishment of required instream and minimum flow levels.

STORAGE

Surface water supplies are crucial to the lives and livelihoods of most people in the SSRB. The majority of people in the basin rely on rivers, lakes, reservoirs, or irrigation canals for their domestic water. Most industries also depend on surface supplies rather than on groundwater, and irrigators, by far the largest consumers of water in the SSRB, rely totally on surface water.

The natural supplies of surface water in the SSRB are highly variable, both annually and seasonally. The needs for this water do not match these variations and are usually highest when natural supply is lowest. Figure 4 shows the seasonal relationships of natural flow, irrigation water demand and irrigation storage reservoir operation. Storage on various scales from farm dugouts to major on-stream reservoirs has proven necessary for coping with supply problems in the basin, and has been used extensively to the advantage of domestic, municipal, irrigation and hydro-electric users. While storage has been developed in the SSRB primarily to serve these consumptive uses, it also produces secondary benefits and negative impacts on other uses. It is this mixture of opportunities and impacts that was the central issue regarding storage at the Hearings. Related issues raised were the potential for multi-purpose use of storage facilities and the relative suitability of off-stream versus on-stream storage options.



SEASONAL RELATIONSHIPS - NATURAL FLOW, IRRIGATION WATER DEMAND AND IRRIGATION STORAGE RESERVOIR OPERATION

Figure 4

Advantages and Impacts of Storage

The advantages and impacts discussed here relate primarily to opportunities for the use and enjoyment of the streams of the SSRB. Economic arguments regarding specific storage are beyond the scope of this report. In particular, economic aspects are project specific and must be considered separately for each case.

Storage allows control and stabilization of water resources: it provides water when needed for consumptive uses and it can be used to control flows to meet instream needs. Without storage, large scale irrigation would not be possible in the SSRB. During the Hearings, much support was received for storage and for the expansion of storage in aid of irrigation. Recreation potential, including lake fishing, can also be enhanced by reservoirs, particularly in the southern portion of the basin where they are virtually the only sites for these activities. Reservoirs provide domestic water for smaller communities, several of which requested increased storage to extend municipal supplies. Control of flows furnishes flood protection and can reduce ice jams. Properly managed flows can enhance instream recreation and improve fishing (such as the Bow River fishery below Calgary, which has benefitted from flow control by the Bearspaw dam). Increased flows relative to uncontrolled low flows can also improve water quality by increasing the capacity for assimilation and dilution of wastes. Many presenters stated that guaranteed quantities of water are needed for these reasons. Though not all of these people specifically requested storage to achieve acceptable instream flows, it is unclear how flows can be guaranteed without storage.

Storage also has negative impacts: sections of river valleys are flooded and natural flows altered. Because of this, storage was cited as an impairment, precluding certain recreation opportunities, flooding farms and wildlife habitat, eliminating stream fishing at the site and altering it downstream. Altered flow regimes can also prevent the downstream environment from sustaining itself: for example, cottonwood forests do not propagate themselves when deprived of occasional floods. Appropriate management is necessary to maintain sufficient flows to provide levels adequate for water quality and other uses.

It is obvious from the above that whether storage is seen as beneficial or harmful is relative. It depends on the particular use or uses that are desired of the stream, and on the siting, design, and management of the storage facility in question. Storage is a tool that should be designed and operated to fulfill a pre-determined role: the uses to be made of the streams of the SSRB and the performance criteria for storage facilities should be established before storage is developed. It is the role of the Environmental Impact Assessment (EIA), required by Alberta Environment, to examine the effects of storage on other

users and the environment. The Panel strongly supports the use of a comprehensive EIA in decisions regarding the development of storage and associated operating procedures in order to provide background information to minimize negative impacts.

Management for Multi-purpose Use

As noted above, reservoirs in Alberta have long been used for activities other than their principal use, and flows controlled by storage facilities can also benefit other users. Several presenters at the Hearings called for more multi-purpose use of storage facilities, noting the considerable potential that exists for the benefits of storage to be enjoyed by wider sectors of the population.

Multi-purpose use of storage is, however, not without problems because of conflicting needs. For example, level changes in a reservoir can impair its use for recreation. On the other hand, residential development and recreational use can make it difficult to use storage for irrigation. Some presenters maintained that, in fact, storage facilities cannot be made and managed suitably for all uses at the same time. In particular, some irrigators held that hydro power generation and irrigation are fundamentally incompatible uses of storage because of the timing each needs for releases of water. The management of the Bow River hydro reservoirs was, however, also put forward as an example of good management that benefits both these users by compromise.

While storage facilities cannot be all things to all people, design and management can improve the compatibility of different uses. Several methods were put forward at the Hearings, most of which emphasized the need for implementation of provisions in the design phase, rather than afterwards. For example: properly designed, waterfowl habitat can be provided in off-stream irrigation storage without seriously interfering with its use, and appropriately designed shorelines or sub-impoundments allow continued recreational use of irrigation reservoirs in spite of drawdowns, enhancing the overall value of the storage facility. Unavoidable negative impacts should be mitigated whenever possible.

The potential for multi-purpose use should be an important factor in the siting and design of storage facilities, as much as is possible within the constraints imposed by the principal function or functions of the facility. Existing storage should also be examined for the potential to accommodate multi-purpose uses. But, just as it is not appropriate to dedicate each reach of every river to all uses, it may not be appropriate to attempt to manage all storage facilities for multiple uses. It is important

to first determine the priorities for use of the river system at the location in question.

On-Stream and Off-Stream Storage

Most people at the Hearings who advocated increased storage supported on-stream storage. Others, however, were concerned about the effects of on-stream reservoirs, though, generally, they were not opposed in principle to the expansion of irrigation or to more storage. Many of these people advocated off-stream storage as a preferable alternative. They saw it as having less impact on the environment, disrupting flows less, flooding little habitat, and more cost effective. In general, these people saw off-stream storage as a means to provide the same or similar benefits for consumptive uses while greatly reducing the impact on non-consumptive ones. Others disagreed because off-stream storage does not provide the control necessary to catch and use enough of the spring flood and because it is not more economical for large volume storage, as the diversion canals and headworks must be extremely large to save enough of the peak flow. Large off-stream storage also results in more evaporative losses from the shallow reservoirs and from the long canals that typically serve them. Several presenters from irrigation areas maintained that effective and efficient use of water requires on- and off-stream storage developed in conjunction, though off-stream storage alone is probably a suitable and more economical option for small scale projects in the early stages of irrigation development. The choice between off-stream storage and a combination of on- and off-stream storage will depend on the particular situation, but, in general, on-stream storage will be necessary as use of the water supply is maximized.

Storage Proposals

The South Saskatchewan River Basin Planning Program had as a starting point the facilities already committed in the irrigation rehabilitation program, including the Oldman River Dam, Keho Lake expansion, reservoirs at Forty Mile Coulee, Crawling Valley, and Badger Lake, and rehabilitation of several headworks and main canals (Base Case, see Appendix 4). Many people, however, chose to comment on specific storage proposals in all sub-basins of the river system.

Bow River below Calgary

Although there are no Government proposals for increased storage on the Bow River, this was a controversial topic at the Hearings. The main points of concern regarded the natural resources of the reach, the trout fishery, and water quality. The Bow River below Calgary is a very attractive section of the river,

with considerable recreation potential, and supports an internationally known trout fishery. Several presenters held that this scenic area and its fishery should not be destroyed by a reservoir between the Bearspaw dam and Bassano. Most of them also supported continued efforts to decrease pollution from Calgary. The Calgary Regional Planning Commission was concerned that a reservoir below Calgary would aggravate water quality recovery by concentrating effluent and preventing aeration. Such possible effects must be considered if a dam on the Bow is ever contemplated.

Most of the presenters who supported more storage on the Bow did not propose a site for a reservoir. Several of them and all downstream communities receiving domestic water from the Bow also expressed concern about water quality: they recommended further efforts to improve water quality and to maintain it at high levels. If more storage is needed in the Bow basin, off-stream storage options should be considered. Such storage must, however, be large enough to meet all needs, and be strategically located to adequately supply users, which includes returning water to the river when needed to supplement instream flows and to supply downstream communities. If on-stream storage is found to be necessary on the Bow, a site downstream of Bassano would be preferable to be closer to areas with the greatest heat units in the SSRB and to preserve the natural amenities and recreation opportunities of the Bow.

Highwood River/Little Bow Basin

Although the Highwood River lies in the Bow basin and the Little Bow River is in the Oldman basin, their management is inextricably linked because of existing and potential diversions from the Highwood into the Little Bow. Communities in the Little Bow and nearby basins are experiencing difficulties in obtaining satisfactory domestic water supplies, and more people are requesting water for irrigation, even though the Little Bow has not been able to supply existing licences in recent dry years. To overcome these problems, proposals were made during the Hearings for more storage and for increased diversions out of the Highwood, with or without more storage. Arguments were also presented against increased diversions during low flow periods and against a reservoir on the Highwood itself because of its importance for fish spawning, wildlife habitat, and whitewater recreation.

In dry years, the Highwood River already suffers from exaggerated low flows below the diversions and from effluent discharged by the Town of High River. Temperature and water quality conditions have precipitated fish kills and, it was submitted, prevented cattle from drinking Highwood water in the summer of 1984. Increased diversions during low flow periods will exacerbate this

situation. For this reason, several presenters, notably including some of those requesting more water from the Highwood for irrigation in the Little Bow, opposed increased diversions during low flow periods. They felt that acceptable quantities could be obtained outside of these periods if storage is provided in the Little Bow basin.

Storage on other tributary streams was also requested to alleviate supply problems for domestic and livestock use, and also for irrigation and recreation. These requests involved small storage facilities on Willow Creek/Pine Coulee, Mosquito Creek, Pekisko Creek, and in Clear Lake.

Oldman River Dam

Although it was not intended to be part of the Public Hearings, the Oldman River Dam was discussed by many presenters. There were strong reactions both for and against it. Those who supported the dam did so because of the increased control of water it affords, primarily to the benefit of irrigation. It was also cited as an amenity for lake-based recreation, including fishing, and for downstream paddling where low flows are augmented. Those opposing the dam maintained it will destroy an excellent fishery and wildlife habitat, alter the natural vegetation for many miles downstream and flood farms on the site of the reservoir. The Oldman River Dam illustrates how differently storage is perceived, depending upon the uses an individual intends for a given river reach. To ameliorate such conflicts, Alberta Environment is planning mitigative measures to be included in the design and management of the Oldman River Dam and nearby streams. The Panel strongly supports Alberta Environment in this regard.

Recommendations

1. Storage is an important water management tool. When it is needed, storage should be located, designed and operated to fulfill a pre-determined role, depending on the valued uses of the stream. In the SSRB, storage is necessary where it is desired to simultaneously meet municipal requirements, maintain acceptable instream flows, and stabilize agriculture by irrigation. To control enough water to satisfy these needs, withdrawals should be made, to the greatest extent possible, from the large surplus of water in the spring flood.

2. Wherever possible, multi-purpose use of storage facilities should be accommodated to provide benefits to as many people as possible.

Identification, rating and implementation of appropriate and compatible uses should be included in the design and management of new storage facilities.

Existing storage facilities should be examined to determine their multi-purpose use potential. The storage facilities and their management should then be adapted, to the extent that multiple use is feasible.

Although multi-purpose use of the resources of the South Saskatchewan River system is supported in general, it should be acceptable to manage certain parts of the river system and its storage facilities largely for special uses where necessary.

3. Mitigation of negative impacts should be considered in the siting, and included in the design and management of new storage facilities and affected areas. Unforeseen impacts should be countered as they occur during the operation of the facility.

   Mitigation measures relative to existing storage facilities should be considered during the review of their potential for multi-purpose use and should be implemented as appropriate.

4. If after examining the potential for strategic off-stream storage, it is decided that on-stream storage is needed on the Bow or South Saskatchewan Rivers downstream of Calgary, it should be located below Bassano to be nearer to the better agro-climatic areas, and to avoid diminishing the Bow's water quality, natural resources and recreation amenities. Beyond this, it should be located in a strategic position to serve the better agricultural areas.

   The use of existing hydro reservoirs on the Bow primarily for power generation should be retained.

5. The needs and opportunities of people in the tributary basins of the SSRB should be examined. Storage in tributary basins should be considered to help alleviate local supply problems, particularly for domestic use.

   In particular, storage in the Little Bow/Highwood tributary basins will be necessary if present irrigation risks are to be reduced, if irrigation is to be expanded, or if municipal supplies are to be improved. Off-stream storage in the Little Bow basin should be carefully considered. Safe instream flows on the Highwood should be maintained to protect its resources for downstream users.

MULTI-PURPOSE USE AND ZONING

As demands for the limited water resources of the SSRB continue to grow, conflict is inevitable. Alberta Environment sees multi-purpose use planning as an important means of avoiding conflicts and of ensuring orderly development to achieve the Province's economic and social objectives. Accordingly, they have made multi-purpose use the underlying principle of all water resource planning and development.

Public opinion at the Hearings supported this strategy. In spite of presenting a wide range of sometimes strongly held preferences for priority of water use, people generally advocated consideration of others in the development and management of the water resources of the basin. Proper location and design of facilities for multi-purpose use and appropriate mitigation measures were seen as central to the balanced resolution of conflicts. Several examples of multiple use benefits in the SSRB were brought forward at the Hearings, including the following:

- in southeastern Alberta irrigation reservoirs are virtually the sole sites for water-based recreation, providing swimming, boating, and fishing opportunities;
- some new reservoirs have sub-impoundments which are not subject to drawdown to serve multi-purpose uses;
- water is released from TransAlta's Bow River reservoirs to assist specific white-water paddling events;
- irrigation supply and distribution systems have produced wetlands for waterfowl and habitat for other game birds; and
- undeveloped river reaches provide unique opportunities for enjoying natural areas through activities ranging from fishing and boating to hiking and photography, and provide critical habitat for a variety of animals.

The Panel endorses multi-purpose use as the central principle for managing the waters of the SSRB. This offers the opportunity to benefit more than one user group by a development or a management plan, often at small additional cost. As a concept and planning tool, this principle can make conflicts explicit and help resolve them. It emphasizes both the need to consider all parties potentially affected by a development or a management plan and the need to consider the connection between the water and the adjacent land. Because of the importance of resolving or reducing conflicts and of the difficulty of avoiding all negative impacts, mitigation of unavoidable impacts on other users (at or

beyond the site) and on the environment should be a key component of multi-purpose use planning and development.

The Panel acknowledges, however, that demands on water resources can be incompatible, and that it is not always possible to reduce all conflicts by multi-purpose planning and mitigation measures. The ability to accommodate multi-purpose uses depends on the site involved, its topography, and its soils, as well as on the nature of the uses. For example, an irrigation reservoir managed for recreation use may not be able to properly fulfill its function for irrigation. Reservoir access designed for boaters for all conditions, including drawdowns, may be unsuitable for swimmers. A river reach with ample public access and facilities for recreation may lose much of its natural character and its wildlife. An on-stream reservoir completely alters the river and its valley, replacing one set of recreation and fishing opportunities and habitats with totally different ones. It is neither possible nor appropriate to use all parts of the river system for all purposes. Implying that all uses can be properly accommodated could raise expectations inordinately and result in disappointments, in spite of the best of intentions and efforts.

Though fully endorsing multi-purpose use as the central principle of water management, and acknowledging the many benefits it can and has provided, the Panel sees a role, when necessary, for zoning river reaches or facilities largely for special uses. This was suggested by several presenters. For example, a reach with unique resources could be preserved in an essentially natural state, or residential development could be restricted from a reservoir crucial to irrigation. It must, however, be recognized that the South Saskatchewan River is a system that is already partially controlled and is used for many purposes: no part can be operated for a single purpose in complete isolation from other influences. Though a reach may be preserved as a natural area, it is no longer possible to ensure flows there are totally "natural". They can, however, probably be managed to preserve largely natural conditions in the environment of that reach, and even to buffer that environment from stressful extremes, such as low flows. In short, the Panel recommends that the principle of multi-purpose use retain its central role in water resource planning and development in the SSRB, but that it be modified to allow zoning of reaches largely for special uses if necessary.[6]

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[6]In Alberta, natural river reaches and their adjacent valleys could be protected as Ecological Reserves, Natural Areas, Provincial Parks or Wildlife Sanctuaries; alternatively, a new class of protection appropriate to rivers could be created.

Information on the resources of the river system is crucial to planning its development and management for both multi-purpose and special uses. Much inventory work has been and is being done. Fish and Wildlife Division is developing a river classification system for fisheries potential to provide guidelines regarding adjacent land use and flow regulation for the consideration of other Government departments. Travel Alberta has classified the major Alberta rivers by canoeing difficulty. Alberta Environment is assessing methods for categorizing reaches relative to several management considerations, such as recreation. Some Planning Commissions in the SSRB have classified river reaches in their areas for their significance for recreation.

This information should be used in the light of the demands on the basin's resources to delineate the opportunities for multi-purpose use and the situations where special protection for single purposes is appropriate. Subsequently, potential conflicts should be determined on a reach by reach basis, and development and management criteria set for their resolution or mitigation. As described in 'Instream Flow Needs', an important step in this process is establishing the flow needs of each reach necessary for the river to support man's uses on a continued basis while sustaining itself.

An essential element in planning and operating a river system to serve multiple interests is communication. This was evident at the Hearings: presenters who had been consulted by or otherwise had access to both Government and private operators or planners of water projects voiced appreciation, while presenters who felt ignored raised several complaints. Communication is necessary to ensure that planners and managers are aware of local conditions, that the needs of users are considered in the development and operation of water resources, and that users are aware of the overall situation, of the constraints and of the range of other needs and priorities involved. Such communication should occur as early as possible in formulating multi-purpose use plans to enable appropriate planning, rather than ad hoc modifications.

Recommendations

1. Multi-purpose use should continue to be the underlying principle in all water resource planning and development in the SSRB. In special circumstances, however, where one purpose is particularly important or sensitive and when it is not possible to make multiple uses adequately compatible, the portion of the system involved should be zoned and managed largely for that special use. Instream flow needs must still be satisfied whether or not a reach or facility is dedicated largely to a special use.

2. All river reaches and existing or proposed water resource facilities of the SSRB should be examined to determine their potential for multi-purpose use or the need for special use zoning. To assist in this, existing data bases and classification systems should be expanded as necessary, and consideration should be made of the long-range effects of any measure. Based on the results, the appropriate multi-purpose or special use planning and management should be carried out. Mitigation of unavoidable conflicts or impacts and establishment of instream flows levels are integral parts of this action.

   Because this will be a large and time-consuming task, attention should first be given to locations experiencing or likely to experience conflicts among uses and to locations with particular potential to benefit from zoning largely for a special use.

3. Efforts should be made to ensure good communications among planners, operators, users, and other parties likely to be affected by a water resource project or management scheme.

4. For new facilities or management proposals, consultations and planning for multi-purpose use and mitigation should be undertaken as early as possible, preferably in the feasibility and siting stages, not added later.

WATER CONSERVATION

There is general agreement among all parties involved that water is an essential and limited resource in the South Saskatchewan River Basin, and that its conservation is a high priority. People differed at the Hearings, however, on how conservation can best be accomplished and on how much is possible at a reasonable cost. Answering these questions is the first important step that must be taken to conserve water.

Although municipalities consume only a very small portion of the water in the SSRB, conservation of water by municipal users is important for two main reasons. First, the amount of water consumed determines the treatment and storage costs to users; conservation can help reduce both capital and operating costs. Second, unlike the situation on the main rivers, some communities place substantial demands on tributary streamflows or on local groundwater supplies. Conservation by these communities is frequently necessary to maintain adequate streamflows or supplies.

Municipalities can conserve water by reducing or eliminating unnecessary consumption and by improving distribution systems. Reduction of consumption is largely a matter of individual effort to change habits and to use more efficient devices in the home. Public information and per unit charges for water supply and treatment can encourage these. Where ageing systems lose significant amounts of water, locating and stopping the leaks may be advantageous. The potential savings must, however, be weighed against the considerable expense involved.

Water conservation by industry is also important because of potential impacts on limited local supplies, and because of industry's demands on municipal systems. Industrial conservation can reduce consumption through more efficient techniques, including recycling. Efficiency standards and withdrawal limitations in rural areas could be used as needed to ensure conservation.

Irrigation use has the greatest potential for water conservation in the SSRB because it is by far the largest consumer of water. Conservation could reduce the demands on both the river system and the irrigation storage and distribution systems, and could make more water available for other users or for irrigators themselves.

Both physical systems and their management are important to the conservation of irrigation water. Ways of conserving irrigation water include:

- improved distribution systems with fewer leaks and less seepage, reduced evapotranspiration, and strategic layout

(including off-stream storage) for more effective and timely distribution and/or for re-use of return flows;

- o control of distribution systems by improved measurement facilities and by automation to improve management and scheduling of water;
- o efficient application systems creating less spill, seepage, and evaporation;
- o matching water application to needs by monitoring soil, crop and weather conditions, and by scheduling to suit crop needs; and
- o land management practices, such as cultivation techniques that improve water retention capability of the soil, and better snow retention.

Several steps have taken place which have improved conservation of irrigation water. The majority of irrigators in larger districts now use sprinklers, which, in most situations, have better efficiency than flood irrigation. In part, the rehabilitation program is improving distribution systems by reducing seepage and evapotranspiration and by making them more effective and timely. Monitoring of main canals has started, and a few research experiments on automation of small laterals are underway.

The principal focus regarding irrigation water conservation, at the Hearings, concerned how much water could be saved at a reasonable cost by efficiency improvements, and whether per unit pricing would be an effective method of ensuring such improvements are made. Many presenters at the Hearings urged that irrigators could and should substantially increase efficiencies. Some also felt that savings should be the basis of future irrigation expansion, or at least a component of it, reducing further storage needs. Irrigators, however, maintained that, though some improvements can and must be made, large increases in efficiency are unrealistic given the nature of the system and the need to keep costs reasonable. Some losses, such as distribution system evaporation, cannot be controlled. To a degree, some other losses may be necessary for proper land management, e.g. some deep percolation may be needed to control or prevent accumulation of salts. Adequate head must be maintained to properly operate relatively flat, open canal systems to ensure all irrigators receive their allotment of water.[7] This results in operational spills, which are often tallied as inefficiencies

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[7]Canal systems must be relatively flat to service the maximum amount of land possible and to prevent erosion.

and which can be a large part of District efficiency losses. The costs to eliminate seepage, evaporation, and spills throughout a District by pipelining are currently prohibitive, and pipelining can not be done on canal grades without considerable energy costs for pumping.

It is difficult to estimate the irrigation efficiencies that might reasonably be attained in the SSRB. Some existing components in the basin may be approaching 80% to 85% efficiency. If efficiencies as high as these, for example, could be achieved in each component of a District (the headworks and main canals, the distribution system, and the on-farm works), the overall District efficiency would be about 60% to 65% (85% x 85% x 85% = 61.4%). Present Irrigation District efficiencies are roughly estimated to be 30% to 60%. All parties involved seem to agree that adequate measurements are lacking, and that without them, it is not possible to specifically know where savings might be made or how each system should be operated to minimize spills and other losses. It is very important that this information be obtained to focus efforts at improving efficiency and to gauge the effects of system improvements.

Although all parts of the irrigation system contribute to losses, the public often focused on the farmer's role. Several presenters advocated encouraging conservation via per unit water charges to the farmer. There appears to be evidence, however, that farmers currently under-irrigate because of a combination of inadequate understanding of both soil moisture conditions and crop water demand, and the financial pressure of the immediate costs of pumping water. Pumping costs are usually greater per acre than the acreage levy, and are, in effect, an incentive for efficient use of water. Moreover, studies that predict conservation of water by per unit pricing to irrigators base their predictions on municipal systems, which use pressurized pipelines. Because the physical systems are completely different, these results should not be extrapolated to irrigation in southern Alberta. For example, the farmer's ability to reduce evaporation by timing of applications is constrained by the nature of the system: he requests water when his crops need it and must irrigate when the water arrives, regardless of weather conditions or time of day.

There is probably little to be gained, at present, from pricing water supplied to the individual farmer. This would be more appropriate when the distribution systems are improved. Rather than metering the individual, monies from charges to irrigators and from Provincial Government investment are presently better invested in continued rehabilitation and in measurement and analysis of distribution systems to enable better management, especially improved scheduling. Irrigation Districts and irrigators must also properly maintain the system to ensure the benefits of rehabilitation are not lost, resulting in inefficient

operations and increased demands on the rivers and storage systems.

With the shortage of water in the SSRB, conservation is very important, but irrigation efficiency improvements may have some unexpected consequences. As irrigation becomes more effective and efficient via better distribution systems and on-farm practices, water consumption could increase. The farmers may further intensify irrigation, taking advantage of improved delivery capabilities to apply enough water to maximize yields or profits (optimum yield). Already, in some rehabilitated areas, District supplies are having difficulty meeting farmer demand. Also, reduction of spills and re-use of water within Districts to increase efficiency will reduce return flows. Efficiency improvements may therefore result in less water being available for reassignment for other uses, including supplementing instream flows.

Also, the environmental impacts of water conservation practices are not all completely clear. For example, using less water could reduce deep percolation, therefore, limiting the flushing out of salts. The increased use of herbicides in order to reduce tillage, as a soil and water conservation process, may result in streams receiving more of these chemicals in certain runoff situations. Even though such impacts are only hypothesized, the implications should be examined.

Dryland practices in the SSRB are also important to water conservation. Moisture conservation improves production on dryland farms, which comprise the majority of agricultural land in the basin. Dryland conservation would include methods of snow retention, development and use of drought-resistant crop types, and reduced tillage methods. Because there is far more good agricultural land in the basin than can be irrigated, dryland moisture conservation measures deserve much attention.

Watershed Management

There are potential water conservation benefits and impacts from land use practices beyond the farm. A variety of presenters at the Hearings were concerned about the possible effects on the streams of the SSRB of present and future forestry and grazing practices in headwaters watersheds. For example, clear-cutting and road construction can result in increased erosion and consequent sedimentation. Clear-cutting often increases water yield, but this may not always be the case in a chinook zone, where evaporation can be considerable. Consequently, studies from elsewhere on streamflow augmentation should not be generalized to chinook areas. Moreover, clear-cutting usually results in earlier and more rapid runoff, which would accentuate the spring and early summer peak flow of the South Saskatchewan River system, leaving less water available to downstream users when

they need it. It is important to understand the effects of land uses in the headwaters watersheds of southern Alberta: the effects on yield and its timing, the effects on water quality, and the effects of specific logging and clearing methods on water conservation. Studies are currently being done by the provincial and federal governments into these subjects. The results should be considered in order to ensure acceptable water quality is maintained, and to stabilize water supplies, maintaining recharge capabilities, yields, and the natural timing of discharges. (This is consistent with the Eastern Slopes Policy.)

Land use beyond the Eastern Slopes, throughout the parkland and near tributary streams, can also affect water conservation. Practices such as clearing land near tributary streams for grazing should also be studied. Opportunities to conserve water or delay yields should be given high priority, as water is the limiting agricultural resource in the basin and an important natural amenity.

Recommendations

Municipal

1. Conservation measures should be encouraged. Water metering should be required for all new supplies, and a program of conversion to metered systems should apply to existing areas, allowing a reasonable period for completion.

Industrial

2. Conservation measures should be encouraged, and should be required where consumption is high relative to the local supply, especially where this is particularly variable. Per unit pricing, efficiency standards, recycling, and withdrawal limits should be used, as necessary, to this end.

Irrigation

3. Water should be conserved by continuing to increase system effectiveness and efficiency through rehabilitation, improved system layout, re-use of return flows, and proper maintenance of the systems.

4. Distribution systems should be monitored to determine the nature and location of their losses and how the systems can best be managed.

   This information should be used to make specific efficiency improvements.

5. As the distribution systems become more effective and their operation and management understood, and as water supply becomes more scarce, per unit pricing of the farmers' supply should be considered. The pricing structure should reflect the distribution costs of supplying water, including operating and maintenance costs, to encourage inefficient operators to improve their management. It should replace the acreage levy, in whole or in part, as a conservation measure, not as a punitive surcharge or tax. It is also a means of assuring equity for the efficient farmer.

Watershed Management

6. Research should be continued on the effects of land clearing on water yield and its timing, and on water quality. This should be done, for both the Eastern Slopes watersheds and for lands near tributary streams throughout the SSRB, in order to properly manage water throughout the whole basin.

7. Opportunities to conserve water or water quality should be acted on.

Research and Information

8. Research and distribution of information on the following should be continued and expanded, as appropriate:

   - water and moisture conservation measures on land, to be used by both dryland and irrigation farmers;
   - drought-resistant crop development;
   - soil and crop needs, and weather monitoring/prediction;
   - efficient methods of irrigation, including crop requirement guides and water scheduling; and
   - possible environmental impacts.

ALLOCATION TO APPORTIONMENT

Background

The amount of water which Alberta is entitled to consume or otherwise withhold from the total annual flow of the South Saskatchewan River system is established by the terms of a Master Agreement on Apportionment (Appendix 4) signed by Canada and the three Prairie Provinces. This Agreement, which was executed in 1969, allows Alberta to divert, store, or consume half of the natural flow of the South Saskatchewan River, as measured at the Alberta/Saskatchewan boundary. Averaged over the fifteen years prior to 1984, Alberta passed on 83% of the natural flow to Saskatchewan. In 1984, the flow to Saskatchewan was only 59% due to the low snowfalls in the previous winter and the intensely dry summer throughout the basin. This illustrates the high degree of variation in flows affected by climatic conditions.

The Provincial policy for management of water in its river basins considers the South Saskatchewan River as a single basin for Apportionment purposes. On average, the total basin flow is made up as follows: 21% from the Red Deer River; 43% from the Bow River, and 36% from the Oldman River.

In 1984, an extremely dry year, the total natural flow in the South Saskatchewan River Basin was 4,220,000 acre-feet, one of the lowest flows ever recorded. In that year, the three rivers in the system contributed to apportionment as follows:

> Bow River - 1,240,000 acre-feet (65% of its natural flow);
> Oldman River - 640,000 acre-feet (39% of its natural flow);
> Red Deer River - 622,000 acre-feet (95% of its natural flow).

In considering an allocation policy for the contributions of the individual rivers in the SSRB to Apportionment, it is necessary to account for the diversions of water from one sub-basin to another, which are now established parts of the system. In 1984, for example, 17% of the recorded flow of the Red Deer River at the Saskatchewan border came from return flows that originated as diversions out of the Bow River into the irrigation systems of the Western and Eastern Irrigation Districts. It has been generally assumed in some areas that the irrigation which has developed in the Red Deer River basin has been confined to the recent Sheerness and Deadfish projects, along with some private irrigation pumping directly from the river. In fact, close to 200,000 acres that are part of the Red Deer River drainage basin are being irrigated using water from the Bow River, as part of the Eastern and Western Irrigation Districts. Similarly, water diverted from the Bow River for the Bow River Irrigation District irrigates land in both the Bow and the Oldman River drainage basins. Return flows from this Irrigation District go into the

Oldman River. The Oldman River system, through the St. Mary Irrigation District, irrigates a part of the South Saskatchewan River Basin below the Bow junction. The South Saskatchewan River Basin Planning Program Summary Report did not take into account these diversions in its calculation of contributions to Apportionment. The actual distribution of water and irrigated acreage indicates that individual river basin boundaries have not, generally, limited water management, which confirms the appropriateness of managing the SSRB as one basin. This distribution also shows that, contrary to popular opinion, it is not the Red Deer River but the Bow River that is subsidizing irrigation in the other basins.

Significantly higher Apportionment allocations from the Bow and Oldman sub-basins than those currently made will have a negative impact on existing irrigation in these sub-basins and will either result in excessively high risks of water shortage compared to present levels, or require a dramatic increase in storage.

The individual rivers of the South Saskatchewan River basin do not often have coincidental flow histories. Under the existing policy, there has been the option of making up the committed flow to Saskatchewan by using water from the sub-basins having better supplies during the particular low flow situation in question: this is a practical and flexible policy.

Public comment took diverse views with respect to allocation to Apportionment, but generally centered on three issues:

- Alberta should make the best possible use of the 50% flow of the South Saskatchewan River Basin to which it is entitled;

- a significant number of presenters recommended that instream flows that are sensitive to the needs of each reach should be established to ensure sufficient water for instream uses and environmental preservation; and

- water should be available and safeguarded to support economic development regionally. Most people who made this point supported an allocation formula which would provide the greatest supply of water for their region. The most pointed representation of this view came from areas where irrigation activity to date has been limited. Nonetheless, expectations were voiced that expansion should also occur in and around existing Irrigation Districts.

As a general principle, public representation favoured assignment of the limited remaining supply to areas where the best returns would result due to soil and climate conditions, where investment and management commitments would be made by the farmers, where the lowest cost would be incurred in providing infra-

structure, and where reasonable access to value adding processing is available.

In considering the assignment of the remaining available water, it was also indicated that comparable opportunities should be available whether such water goes to extension of existing irrigation systems or to new areas, regionally dispersed, which need to develop new infrastructure. It is the Panel's opinion that Government policy, including funding support, should be equal. In particular, when comparing irrigation expansion costs between the expansion of existing Districts and the development of new areas requiring total infrastructure, there should be an accounting for a proper share of the infrastructure already paid for in serving the existing District systems.

It has taken an extensive period of time for the irrigation systems of the basin to develop to their present level. There remain many areas where climate and soil conditions are suitable and where there is a desire for the opportunity to develop irrigation. For example, there is a wide difference in the degree of irrigation development between the Lethbridge/Brooks area and the Medicine Hat/Red Deer basin area. The remaining water supplies for irrigation should principally be assigned to the agro-climatic zones having the highest potential, when supported by the willingness and ability of the farmer to invest. However, because development of irrigation takes time, it may be prudent to reserve a reasonable amount of water for irrigation in the suitable, but undeveloped areas near Medicine Hat, in the Red Deer basin north of the river, on the Blood Indian Reserve, on the Peigan Indian Reserve and on the Blackfoot Indian Reserve. The amount should be subject to periodic review, particularly regarding the initiative taken by local farmers and the effectiveness of the use made of water.

A number of presentations to the Hearings expressed the concern that the Red Deer River would be used to satisfy Apportionment to a major extent. They felt that the Red Deer River was, therefore, "carrying" the areas served by the Bow and Oldman Rivers, and they advocated equal percentage contributions to Apportionment from each river. However, when return flows are properly credited to the source rivers, it becomes apparent that in critical flow years it is the Bow River, not the Red Deer, that subsidizes the other river systems.

The SSRBPP Summary Report illustrated by scenarios a number of options for allotting irrigation expansion, including water, in the three sub-basins (Red Deer, Oldman, Bow). It is possible to compare, at least roughly, the cost variations and other implications resulting from the application of these options. The scenarios illustrate that as irrigation development is maximized expansion would cost substantially more per acre for a 50:50:50 allocation than for a 90:30:30 allocation (Red Deer, Bow, and

Oldman Rivers, respectively). Additionally, maximum irrigation expansion with an equal allocation formula (50:50:50) cannot practically be accomplished, even with considerably higher unit expenditures, because of the amount of flow control and the carry over storage required.

While adoption of a formula that designates the amount of flow each river must contribute to Apportionment to facilitate the future distribution of the water supply has merit from the point of view of administrative processes, there appears to be potential for undesirable consequences. Concerns were expressed that a fixed allocation formula would cause a parallel effect in fixing the locations in which investments would be made. This could result in precluding investment in locations considered best by the investor, whose commitment and well-being should be major factors in decisions on water licencing. Additionally, if a fixed formula were established, there would be an expectation that the government was committed to assuring supplies to those areas according to the limits resulting from the formula. This could imply government support for infrastructure to meet the conditions affected by the formula, rather than support for willing investors' initiatives in the best physical and economic conditions.

Since the individual river flows are affected differently by weather conditions, fixing the formula for allocation could also reduce the flexibility now enjoyed in meeting the Apportionment flow by using surpluses which exist in some of the sub-basins during low flow occurrences.

The allocation question is fundamental to water management and to the entire spectrum of economic development in the SSRB. In the final analysis, decisions on how water will be distributed or committed, including satisfying the institutional requirements on Apportionment, will have a very major impact on the management of this resource. In order for an allocation policy to be effective and to deal with the issues raised by the public, it must satisfy important criteria:

- the Government of Alberta must ensure that Alberta continues to meet its commitment to Saskatchewan;

- the government, having the authority to manage the water resource, has the responsibility also to protect the broad spectrum of public uses which are deemed to be of value; therefore, any policy dealing with Apportionment must first ensure that the valued instream uses are protected in each river in the basin; and

- the government has the additional responsibility to assure fairness in its support to water development programs, to be responsive to orderly and effective use of the resource, and

to ensure a distribution of the benefits directly and indirectly for the betterment of regions and people throughout the basin.

Recommendations

To ensure meeting the needs identified, the Panel recommends the following, which also have ramifications for licencing policy:

1. The government continue to manage water on a river basin basis, considering the South Saskatchewan River system to be a single basin for the purpose of Apportionment.

2. The government continue to honour the terms of the Master Agreement on Apportionment between the prairie provinces, based generally on 50% of natural flows on an annual increment basis.

3. A range of instream flow amounts be established by government for the reaches of each river to satisfy the following uses and to provide adequate protection for the natural environment:

   - o safe supply for municipal needs, including effluent assimilation;
   - o protection of fisheries habitat;
   - o protection of valued riparian environment; and
   - o protection of significant recreational opportunities.

4. Water should be used to support and improve the economic viability of agriculture and industry, to support regional development initiatives in a fair and equitable manner and to facilitate intensification and diversification of the agricultural base.

5. In summary, it is recommended that a fixed allocation formula should not be established. To facilitate this recommendation, government investment, which will be a major determinant of both location and magnitude of development, should be directed in a manner which will ensure that the initiatives of the farming community to invest are not unfairly biased towards development in existing Irrigation Districts, as compared to new, more regionally distributed areas.

6. A supply of water should be reserved for some strategic water-based development in the basin, including irrigable areas north of the Red Deer River, along the South Saskatchewan River in the Medicine Hat area, on the Blood Indian Reserve, on the Peigan Indian Reserve, on the Blackfoot Indian Reserve and in other areas, when needed. A volume of water capable of irrigating a total of approximately 150,000 acres is suggested, subject to confirmation that suitable soils and topography in high heat, frost-free zones are serviceable at comparable costs for irrigation throughout the systems. Such a reservation should be subject to reviews at five-year intervals to determine whether the irrigation uses and investment, including farmer investment, supports increasing or decreasing the reservation.

LICENCING OF SURFACE WATER USERS

Conditions affecting licencing, particularly of surface water users, resulted in a large number of inputs to the Hearings. The vast majority of the concerns expressed related to the large water withdrawal licences associated with irrigation agriculture. For this reason, the most significant licencing issues to consider relate to irrigation and focus on the water-short basins. Comments varied from statements that over-allocation was evident during rather frequent low flow periods to suggestions that increased licencing opportunity should be available for those wishing to take advantage of water supplies for irrigation when they are available. Under modern irrigation processes, the high level of farmer investment was deemed, by the public, to require reasonable security for a continuous water supply. There were also suggestions that the private irrigator had an inferior position compared to the irrigator in a District, insofar as priority for sustaining his water supply. It seemed generally accepted by the public that the prior allocation "First in Time, First in Right" policy for licencing is necessary, providing its subsequent application in times of critical supply is fair and reasonable.

While there seems little argument against the process of prior allocation establishing priority in the assignment of water rights to users, a review of the policy as it relates to shutdown during critical flow periods is suggested. Differences, which may only be apparent, respecting security of water supply between the private water user (irrigator) and those supplied as part of Irrigation Districts should be clarified to assure fairness in the application of policies and practices.

As water amounts become licenced to the maximum level from the supply available, it will be important that optimum uses be achieved, to the point of reassigning present licences which are relatively unused and where effective and efficient use of the water is not being demonstrated. It will be prudent also to limit licencing or to provide limited licences related to both supply and time, particularly for the uncontrolled tributary streams which are subject to erratic and extreme fluctuations in water supply. Additionally, final issuance of licences should not be made in those cases which would rely on subsequent development of flow control or storage until these facilities can provide the increased security in water supply. At best, limited licences could be issued which would reflect real potential for shutdown on short notice or otherwise at prescribed dates.

In considering the licencing process for the future, the procedure which will apply during periods of water shortage should be adopted and clearly enunciated.

Recommendations

It is believed that optimum use of water and a reasonably secure supply should be the objectives of licencing water uses in the basin.

1. The system of licencing according to the principle of "prior allocation" which establishes the priority of one user over another based on the date of official application, should continue as the primary basis for licencing water uses.

2. A comprehensive review of all licences and assessments should be made by the Government and the Irrigation Districts to determine whether the water that is committed is being efficiently and effectively used as intended by the Province's Water Use Objectives and the applicable public investments. The results of such a review are deemed essential to the consideration of further licencing, to reduction or re-assignment of licences, as background data for developing potential improvements in efficiency, and to assist in the enhancement of water management processes, all aimed at maximizing the benefits of irrigation and other water uses.

3. While the assignment of licences according to the principle of "prior allocation" is accepted insofar as determining the priority order of water users, there is a need for Government to have the authority and a working policy which can vary the priority system regarding the amount and continuity of supply during critical water supply periods. The authority to alter the priority right should allow for such options as rationing supply to all users, rotation of supply, curtailment of certain uses and/or transfer of selected uses to others.

   If necessary, legislative changes should be initiated to provide this flexibility. The condition for licencing should assure the private irrigator supply security comparable to the Irrigation District irrigator.

4. Under current practices, the shutdown of water to large consumptive users (irrigation primarily) has occurred largely where supply in streams is uncontrolled and during the three summer months. Licencing from such supplies should therefore reflect the summer flow patterns for supply and be limited accordingly. It is recommended that the licencing of water supply from uncontrolled streams and/or from streams with limited control should be at a reduced level in comparison with those with adequate control and which have the capability of using water stored during the higher flow periods. Where withdrawals are taken from

relatively uncontrolled streams during the low flow summer periods, licencing could be limited to as low as 25-30% of the mean annual flow.[8]

In general terms, licencing is necessarily linked to water supply and the degree to which the supply can be stabilized and consistently maintained. The flow control and consistency in supply where both on and off-stream storage is built into a system is much more assured than in systems where diversion directly out of the stream is the main supply process. Lower levels of licencing should apply to the lesser controlled systems.

The approximate amount of licencing which could be issued in reasonably developed and controlled supply situations might be limited to the acreage which could be served with 35-45% of the mean annual flow.[8] The degree to which water supply is controlled and stabilized is a major factor to be taken into account when gauging the limits for licencing water uses.

5. The Panel also agrees with the principle of maintaining safe in-stream flow levels as a commitment which needs to be imbedded in stream management policy. It is therefore considered that management policy over the licencing of the water uses, particularly those which withdraw water from the river system, must first safeguard the in-stream flow requirement.

6. New licencing should be restricted to that which can be supplied by the supply system in effect at the time, and, where new management and control facilities are being planned and constructed, should await that supply being developed and secured before licences are issued. At the very best, such new agreements or licences which will rely on future storage for supply, whether in a District or private, should only be conditionally issued with specific limitations on both quantity and timing. Moratoria in effect awaiting flow control and/or storage should be maintained.

7. It is recommended that the Province should retain the present level of licencing to the Irrigation Districts until expanded and upgraded management facilities and/or proven efficiency gains provide a reasonably continuous supply of water to satisfy the existing irrigation together with any new irrigation planned by the Districts.

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[8]With a potential 1:10 year shortage cycle.

8. Commitment of water to licencing should respect any policy formulated to ensure a reserve capacity to absorb the effects of unexpected occurrences and shifts in demand.

ADMINISTRATION

Inputs to the Panel on water resources administration covered a wide variety of issues and a similar range of opinion. A common thread through these inputs expressed the need for a practical and timely decision-making capacity which should apply consistently throughout the organization. It was also noted that there was a desire for clear-cut lines of communication and procedures for delivery of service to the public. Generally, the public acknowledged that water management was often very complex and technical in nature; however, they still wanted the framework of decision-making shortened as much as possible and to be readily accessible to them.

It was perceived by some presenters that there was potential for conflict of interest by reason of the Department of Environment's overall responsibility for development and management of water resources together with development of the standards and enforcement of water resources protection.

While the Department of Environment has the major mandate and responsibility to technically and administratively respond to the wide range of water resources issues, other departments and their clients' uses impact this administration and therefore incur some sharing in the responsibility (e.g. efficiency in irrigation agriculture).

It is the view of the Panel that water management development and water quality protection are so intimately connected that it would be inappropriate to segregate the integrated management functions embracing both areas. In fact, considerable public input to the Hearings indicated support for increased co-ordination between the various management elements affecting the water resources in the basin, which requires responses from a number of departments. Close co-operation between the appropriate disciplines for optimum response to multi-use activities and objectives was also recommended.

The Panel generally concludes that splitting the Department, with the objective of separating those responsible for dealing with the quantity side of water resource management from those dealing with quality factors and enforcement of standards would, in effect, reduce the potential for the essential close co-operation. It is not believed that separation, with the possibility of creating adversarial roles, would improve the decisions on management affecting these areas as both elements are generally involved.

Over the province as a whole, it is not possible to generalize the priority which each water use will have and a standard approach to considering the relative importance of each element. In the SSRB, the physical features affecting the water supply and

its wide variations, the favourable agro-climatic conditions, and the wide range of public recreation usage require specific management policies. It is necessary that comprehensive multi-use planning give due attention to the predominant uses, but also be sensitive to environmental protection, particularly for the safety and enjoyment of the water supply. It will be incumbent on the administrative department at all levels to ensure that inappropriate biases are not permitted to influence the proper balance between the development of water management facilities, their operations, and environmental protection, which is essential. It is concluded that the Environment Department structure, which covers both quantity and quality management, is appropriate, but carries the responsibility for maintaining balance at all stages in its planning, development, and operations, and must respect the many water resource uses which are affected in the basin.

This southern water basin, where supply is limited and demands are reaching the limits of supply, also has the potential for higher rates of pollution and increased competition for water. This will place increased pressure on the Department for higher degrees of management refinement and more sensitive control and distribution of the supply, including optimization of facilities in the system. It will, therefore, be essential to ensure high levels of both technical and administrative competence. A responsive communications system should keep the public informed continuously, beginning with the early concept and planning stages, where significant policy changes or projects are under consideration. The South Saskatchewan River Basin Planning Program included extensive communication of information to the public which resulted in high quality responses from them.

The water resource in the province as a whole, and particularly in the SSRB where the supply is limited, is increasing in relative value every year. The Panel, therefore, supports the maintenance of a strong, resourceful department with the flexibility to adjust practices as necessary to effectively manage increasingly complex water supply and demand requirements.

Recommendations

The Department of Environment's administration should:

1. Ensure that the internal management structure of the department provides for continuous co-ordination between the divisions to facilitate optimum consideration of the elements having an influence on decisions.

2. Ensure that the management process provides for consistent and complete interdepartmental co-ordination on matters essential to comprehensive water resource management.

3. Ensure that program delivery procedures are streamlined and simplified as much as possible, for effective access by and service to the public.

4. Ensure a consistent and timely public communication process for significant water resource issues.

EXECUTIVE SUMMARY OF PRINCIPAL RECOMMENDATIONS

The waters of the South Saskatchewan River basin are central to the quality of life of the basin's residents. The management of water to help achieve economic and social goals in the basin in an environmentally sensitive manner should be assured. Consequently, multi-purpose use is the underlying principle for all water resource planning and development. Water should be used to support and improve the economic viability and stability of agriculture and industry, to facilitate further intensification and diversification of land base uses, and to support viable regional development initiatives. It should also be managed to sustain the basin's natural and recreational amenities. While establishing priorities for water uses will provide appropriate administrative tools for assigning water, particularly to the consumptive uses, assuring and maintaining satisfactory instream flow levels is a prerequisite to all water resource planning and management in the basin.

Initiatives to stabilize and intensify the agricultural and industrial economy and to maintain satisfactory instream flows, in the face of the highly variable nature of the water supply and climatic conditions, require high priority for control and storage of the available water.

To maximize the benefits to all, water uses must become increasingly efficient and effective. Conservation practices need high priority by all users in the basin.

The water quantity and quality components in the basin are totally interrelated, particularly in respect to policies for water management facilities and operations. Recreation, fisheries, shoreline habitat, and downstream domestic users are intimately affected by adverse combinations of these factors. Appropriate consideration of them commences in the concept stages for facilities and operations. Multi-disciplinary decision-making is essential to optimize and harmonize uses.

As populations increase in the basin, constant vigilance and action will be necessary to ensure and safeguard adequate quality for the wide range of water uses. Reasonably accessible, safe drinking water should be assured for all users.

Irrigation is the largest consumer of water, by far, in southern Alberta. Decisions regarding irrigation will be major influences on the water resources, the water users, and the economy of the SSRB. Consequently, the topic of irrigation is prominent throughout this document, directly and indirectly. This does not, however, mean that this report is concerned with irrigation as a priority over other uses. Rather, it means that irrigation

management and all its implications must, of necessity, be fully considered to properly accommodate all water uses in the basin.

The concentration of the largest consumptive use of water in irrigation is currently in areas commanded by gravity systems supported by relatively limited on-stream storage designed primarily for that purpose. With the strategic locations and the land elevations commanded by these systems, it has been practical to extend irrigation into adjacent drainage basins. New storage and enlarged conveyance systems now committed will support infilling and expansion within reach of these facilities. A single basin management concept is, therefore, well established. Additional water which can be made available with further supply management projects should be assigned to suitable soil and climatic areas where both public and water user investment is viable.

The completion of the major rehabilitation and expansion of the storage and delivery systems will make the existing irrigation operations more efficient and will increase production on lands converted from dryland farming. Benefits to the irrigators are expected to increase. Charges to the water users should reflect the share of the benefits accruing to them and should also ensure adequate operations and maintenance funding to keep the system at a high level of efficiency. It will also be prudent to accumulate funds for future component replacements which may become necessary. The option of basing water charges on measured quantities should be considered to encourage inefficient operators to improve their management.

The current rehabilitation and expansion program for both headworks and District conveyance systems will facilitate irrigation expansion to a total of approximately 1.440 million acres, an increase of roughly 400,000 acres over the present level. This acreage can be increased subject to the degree to which more intensive storage and management is justified and the level of water-shortage risk which is acceptable. In considering the risk factor, it is necessary to take into account not only the position taken by established irrigators, but also those dryland operators desiring to irrigate on some scale to mitigate drought or to supplement their dryland operations. The application of an optimum risk factor will also influence licencing limits.

The expansion of irrigation, the major water consumer in the basin will require the development of infrastructure systems and mobilization by farmers, and will take considerable time. It will, therefore, be appropriate to reassess benefits and costs as further phases of expansion are being considered, and to relate this to the economic capabilities of the Province and the irrigators current at that time.

There is a general desire for secure and stable domestic water supplies, which will require, in specific situations, the development of water sources and some storage capacity increases to sustain supply for longer periods. This applies to requirements of individual farms, municipalities and other users across the whole of the basin.

The extent to which surface water can be committed, on a prudent basis, must reflect the best judgement of background information on flow histories and the degree to which the supply is managed on a year-round basis by the storage facilities and the operating regime. The water withdrawal commitments from small uncontrolled streams should be substantially less, proportionally, than from the larger, managed streams equipped with optimum on- and off-stream storage facilities. It is also observed that small streams require a higher percentage of flow retained to provide at least minimum protection for valued instream fisheries and other uses.

Groundwater is essential to supply many rural and municipal users and is a significant source for the oil well flood recovery process. The optimum use of groundwater should be based on sustaining the aquifers and must ensure the long term supply of water for essential domestic uses.

In the future, there will be potential for shifts in water requirements between segments of society, such as the growth of high tech industrial developments, changes in agricultural products and markets, and new recreational initiatives. To allow for such potential changes in demand, together with ensuring capacity to absorb the effects of unexpected occurrences, natural or otherwise, it is suggested that the water resources management process should retain a reasonable quantity of water in reserve and uncommitted.

Putting research and information to work will be an essential function of all levels of management and operations to maximize water use effectiveness and to meet the expected increases in competition for agricultural and industrial product markets, while at the same time protecting water quality and instream flows. Initiatives in this area should concentrate on applied research and on distribution of resulting information and advice to the users.

The major policy questions cited in the SSRBPP Summary Report were:

- How is the supply of water to be allocated among uses?
- How shall water be managed to support these uses?

- How should the waters of the Red Deer, Bow, and Oldman Rivers contribute to the amount that Alberta must supply to Saskatchewan?

These three policy issues are mutually dependent and interface with: the inseparable factors of quantity and quality, a variety of multi-purpose use implications, the uncertainty of extended time-economy projections, the desire and ability of users to make significant investments, and the potential for shifts in water use needs in the future.

The following are the principal recommendations consolidated from those detailed throughout the report. They reflect the Panel's interpretation and judgements of the Study results, the Public Hearings inputs, and the responses to questions from the Panel by individual presenters, groups, agencies, and provincial departments.

- Initiatives to use water to stabilize and maximize the agricultural and industrial economies in the basin while sustaining its natural resources are justified.

  To achieve these economic and natural resource goals, including maintenance of satisfactory instream flows, and, at the same time, to protect other uses in the face of the highly variable nature of the water supply, requires that high priority be given to control of the available water. It is, therefore, recommended that increased storage and other control measures, including those structures already committed, be comprehensively planned and developed to satisfy multi-purpose uses and to minimize environmental impact. The operating regime of the managed system should provide for the major beneficial uses and ensure satisfactory instream flows for other purposes.

Multi-purpose Use

- Multi-purpose use should continue to be the underlying principle in all water resource planning and development in the SSRB. In special circumstances, however, where one purpose is particularly important or sensitive and when it is not possible to make multiple uses adequately compatible, that portion of the system involved should be zoned and managed largely for that special use. Examples of such special uses could range from preservation of a reach as a natural area to management of a reservoir primarily for irrigation. Instream flow needs must still be satisfied whether or not a reach or facility is dedicated largely to a special use.

Security of Domestic Water Supply

- The Province, together with local governments, should support programs to progressively increase the stability in water supply for domestic purposes, including:
  - development of sources to serve areas where chronic shortages have occurred and supply limitations seriously deter viable economic development;
  - adequate storage capacity to sustain supplies during extended periods of drought and/or where increased volumes must be stored during periods of higher flow from normally low production sources.
  - strategic regional utility distribution systems to connect stable water supply sources to user groups;
  - upgrading water quality to a usable level by treatment where alternate sources are not economically available.

  Improvements made to date are commendable and the process should be continued. Drought-proofing is justified to minimize recurrent emergency supply operations.

Water Quality, Treatment and Instream Flow Factors

- Surface water is the major supply for water uses in the basin. Safe water quality for public use and for sustaining instream life in surface waters should not be compromised.
- It is recommended that a system of optimum stream regulation be established that limits and co-ordinates withdrawals with residual flows to assure adequate water for the safety of downstream domestic users, for effluent assimilation, for protection of fisheries and other natural resources of value, and for control of vegetation growth. Stream control facilities, including storage, should be used as required to adjust flows to meet instream needs.
- At the same time, effluent treatment will need to accommodate increasing populations and industrial activities. With the growth in demand for water for numerous uses, it is unlikely that more water will become available to assimilate the increased volumes of waste. More intensive waste treatment will be required in the future, particularly where discharges are large relative to low season flows. Alternatively, reduction of this effluent load by land disposal of treated sewage, including using irrigation processes, should be comprehensively evaluated as an option to instream assimilation.

- Safe, palatable water quality is as important for human consumption as is the availability of water itself. It is recommended that the Government evaluate and financially support water quality assurance where abnormal conditions affect domestic water supply and increase costs significantly. Additionally, advanced sewage treatment may be made significantly more costly when large-scale withdrawals for irrigation cause major flow reductions in the receiving streams. It is, therefore, recommended that the Province assess the effects of withdrawals authorized for non-domestic purposes to determine whether it is equitable for the community responsible for sewage treatment to absorb all or a portion of the resultant cost increases.

- The protection of water quality should commence with preventative measures to eliminate or minimize the movement of pollutants into the water supplies, concentrating first on areas near larger cities and industries. Informed public awareness and involvement should be encouraged through access to water quality information.

- Ensuring water quality based on the application of safe guidelines and standards, including waste treatment to appropriate technical standards, has generally maintained good water quality in the basin. It is recommended that the results of ongoing research into potentially hazardous substances and the technological advances in detection, neutralization or removal of them be used to update and improve quality control. Ideally, water quality objectives and effluent standards to attain them should be established for each river reach, considering the variations in natural background conditions.

- It is recommended that realistic instream flow amounts and emergency minimum flow limits be established for each river reach to maintain the essential quality and flow levels necessary to support and maintain valued uses. This evaluation should commence with the reaches in which water shortages occur (e.g. where moratoria limits are in place) and/or where further storage and diversions are being planned. The instream flow criteria should include sufficient water to act as a buffer for unanticipated events or demand shifts, to protect water quality.

Groundwater

The basic principle for guiding groundwater use and management will be to sustain the source aquifers to ensure the long term supply for essential domestic uses and also to serve viable industrial requirements within the restraint limits necessary to sustain the supply.

- Policy and management conditions now in effect to prevent groundwater mining should be maintained, and adequate monitoring should be tailored to the withdrawal rates and the aquifer's performance, and should be done on a continuing basis;

- The Provincial Government should support programs to upgrade water quality where abnormal conditions affect the supply, resulting in excessive costs, and where other alternatives are not reasonable;

- Significant groundwater recharge areas should be protected, including preventative measures to eliminate or minimize the movement of pollutants into the aquifers.

Habitat and Recreation

Water is one of the important factors that contribute to the significant and valued natural resources in the basin by providing for both fish and wildlife habitat and for the recreation needs of residents and tourists. These natural resources and recreation opportunities are important to the quality of life and the economic base of the region. In addition to the natural system, the irrigation system in the drier areas augments and provides these amenities where few would otherwise exist. In order to maintain and, where possible, to enhance these uses of the water resources of the SSRB, the following are recommended:

- While the ultimate responsibility for control of water use lies with Alberta Environment, interdepartmental co-ordination is vital to the attainment of multi-purpose use goals. The general public, including local authorities and interested groups, should also be informed and their inputs considered in water use planning.

- A rating system to assess the significance of the natural resources and the relative importance of various uses is a necessary first step in determining which uses are appropriate and attainable for each reach and each lake or reservoir.

- Appropriate multi-purpose use objectives should be included in all phases of planning and implementation of new water

management projects, including the dedication of a portion of stored water specifically to meet these goals. As well, existing structures should be assessed for the potential to incorporate such uses.

- Programs for the retention, development or enhancement of habitat frequently impact landowners. They should, therefore, be actively involved during planning and implementation and their co-operation actively sought. Projects such as wetland retention or pheasant habitat protection should not become financial burdens to the landowners.

Irrigation Development Factors

- The principle of crediting both direct and indirect benefits when calculating the economic viability for the development of irrigation projects and when determining cost-sharing formulae for District conveyance systems is accepted.

  The present irrigation system expansions and on-farm mobilization will take considerable time, during which there are likely to be many changes in economic, technological and market conditions. It is, therefore, recommended that the benefits and costs associated with further phases of expansion be assessed when such programs are being considered, and be related to the province's and potential irrigators' economic situations and capabilities current at that time.

- For the same reason, a farm acreage-economic limit for irrigation expansion cannot be accurately set at present. As significant water developments are considered and planned, regular economic performance tests should be made to guide the amount and rate of investment which is justified by the economy of the time.

Industry

- Water allocations to industrial uses should be assured on the basis of providing positive economic benefits to the region. Industrial users should continue to be responsible for the management facilities required to serve their industries, including measures to prevent the movement of pollutants into the water supplies.

Efficiency and Conservation

- Increased efficiency and conservation practices will be necessary in the management of all water uses. In particu-

lar, the extent of further expansion of irrigation in the basin will become more dependent on maximizing the remaining water supply and in keeping facility investment and operating costs as low as possible.

It is recommended that the facilities and management processes for efficiency include:

- adequate measurement and operational control mechanisms which will co-ordinate and adjust quantities and time schedules to optimize water delivery through the whole of the irrigation supply and conveyance systems;

- guidance to irrigators on the selection of crop types and water requirements;

- water quantity charge policies, practical efficiency standards, and legislative amendments, if necessary, to encourage the improvement of on-farm efficiencies and conservation: wasteful operations should not use water at the expense of efficient operations;

- development of optimum storage for efficient and timely control of water supply, rehabilitation of the conveyance systems to reduce water losses, salvaging of salinized lands, removal of constrictions, and consequent increased irrigated acreage;

- adequate maintenance standards and user charges to retain high levels of system efficiency;

- conservation of water and reduction in treatment costs for both domestic water and sewage disposal in municipalities by converting to universal metering in the water delivery systems; and

- further applied research in refining the operational regimes for distribution systems, water and moisture conservation, drought resistant crop development, and guidelines to gauge water and scheduling requirements.

Regional Development

The use of water for irrigation and industrial development has supported a wide range of benefits in the basin. The investment in irrigation systems, in particular, has provided for much needed stability and diversification of agricultural production and has been central to significant processing industries. These water-supported uses are, therefore, essential for the region's economic and social well-being.

- It is appropriate that infilling be done in the developed irrigation areas where infrastructure expansions are now being constructed and where irrigation can be serviced within economic reach of these systems in order to maximize the use of the facilities and the investments made.

- The distribution of the remaining water which can be assigned to irrigation should be to the better agro-climatic zones where combined infrastructure and operating costs are comparable to costs in existing irrigation areas and where farmer interest and investment will be made. To provide the opportunity and time for irrigation to develop, a reservation of water should be made for approximately 150,000 acres of new irrigation in suitable but undeveloped areas north of the Red Deer River, near Medicine Hat, and on the Blood Indian Reserve, the Blackfoot Indian Reserve, and the Peigan Indian Reserve.

- Additionally, the water supply in the developing upper tributary stream areas should be stabilized to reduce the impact there and downstream of diversions for local irrigation and municipal use during low flow periods.

Allocation to Apportionment

- Irrigation, because of its magnitude and geographic distribution, is the major influence on how the rivers in the basin supply water to Saskatchewan, as required by the Apportionment Agreement. The current distribution systems cross sub-basin boundaries: this both supports and requires the management of the SSRB as a single basin. It is reasonable and practical to continue this policy.

  New area expansions should have equity of Provincial support compared to existing irrigation areas. They will also require a reservation of water to assure the time and opportunity for development, subject to periodic review. It is recommended that agro-climatic and economic viability, including the farmer's investment and return potential, should be the basis for assigning water and assistance to new area irrigation, without fixing a formula for water distribution and ultimate infrastructure investment among the sub-basins.

Licencing Process

- The licencing process should continue to respect the principle of prior allocation insofar as determining the priority order for assignment of water licences. It is

recommended, however, that the authority to alter priority in special circumstances should be established in policy:

  - rationing of supply to all users, rotation of supply, curtailment of certain uses and/or transfer of selected uses to others in periods of critical supply;

  - reduction or cancellation of licences when controllable inefficiencies are not corrected; and

  - reassignment or reduction of licences which are relatively unused and where effective uses are not being demonstrated.

- Irrigation licences requiring withdrawals from streams having limited or no control should have water committed at a reduced percentage of mean flows compared to systems having significant storage and flow control. In general, current moratoria on licencing awaiting the development of storage or efficiency gains should be retained until the additional water supply can be committed. At most, any agreement or licences issued in these circumstances should be conditional with specific limitations on both quantity and schedules.

- Groundwater licences should be conditional on safeguarding essential long term domestic requirements: the withdrawal amount and rate should assure that the aquifers being tapped are not mined.

- Commitment of water by licencing should respect any policy that is formulated to ensure a reserve capacity to absorb the effects of unexpected occurrences and shifts in demands, including the flow requirement to assimilate treated waste as a safeguard for water quality.

- The process of selecting an appropriate level of water shortage risk as a guide to licencing is largely subjective. While concentration of additional water per acre on presently irrigated lands will increase production significantly on those lands, the alternative of increasing acreage with this additional water is deemed by many to be a better investment. It is recommended that research or investigation be undertaken, as necessary, to better determine whether there is an optimum balance between the options of intensifying irrigation, thus reducing risk on existing acreage, and expansion of irrigation acreage, thus spreading both the opportunities and the risk over a larger total area.

Storage

In order to stabilize the variable water supply to satisfy domestic, municipal, agricultural, industrial, recreation, and other instream uses of value, storage and flow regulation is necessary. Storage is a management tool only; therefore, its location, design and operational regime should be determined by the particular set of multi-purpose use objectives established for the area served.

- While assignment of large volumes of water to major beneficial uses such as irrigation, is necessary, storage facility design and control equipment should be capable of the sensitive regulation of flows to protect the instream water uses of value, and to assure consistent supplies for downstream domestic, industrial, and municipal needs.

- In general, maximization of irrigation will rely on both on- and off-stream storage to optimize water supply and scheduling.

- If further on-stream storage on the Bow or South Saskatchewan Rivers is required, it is recommended that it be located downstream of the Bassano diversion works to preserve the natural amenities upstream and to avoid water quality impacts. Beyond this, it should be located in a strategic position to serve the better agricultural sites. It is recommended, however, that the potential for a relatively large scale off-stream option for the Bow River be evaluated if additional storage is required upstream of Bassano. Such a facility would require substantial inflow channel capacity to capture and divert reasonable quantities of water during periods of high flow and also a means of re-regulating the Bow River via controlled return channels.

- TransAlta is urged to continue its co-operation with irrigators by releasing water to irrigation during critical low flow summer conditions. It is recommended, however, that any increased storage required for irrigation use be located and designed for that purpose.

- Abrupt flow fluctuations by releases from storage should be minimized when it is reasonable to do so during periods critical to fish reproduction and of intensive downstream recreation activity.

- Storage and reasonable limits on withdrawals are necessary in the basin to ensure a controlled reserve of water is available for unanticipated events and to accommodate potential shifts in water demand.

- The development of storage and of its operating regime, should at all times, from concept to operation, take steps to minimize impacts on valued instream habitat and should include appropriate mitigation initiatives.

- It is considered urgent that storage and flow control options and priorities be developed and implemented for the upper tributary reaches, including the Highwood-Little Bow sub-basin, the Willow Creek sub-basin, and other comparable areas currently experiencing shortages for a variety of uses.

Research and Information

Research in support of good water management is recommended in several sections of this report. Both continuation of existing work and new or expanded efforts are called for. Efforts to ensure this research is put to use through distribution of relevant information to the public and, in turn, obtaining feedback are also recommended.

- Two types of research are needed and recommended for water management in the SSRB: fundamental applied research and monitoring.

    - Fundamental research is needed or should be completed to inventory the water resources of the SSRB, rating their potential for different uses and noting problems for, or conflicts among existing or potential uses. To ensure safe, effective and efficient use of water, the impacts of human activities on water quality and supply need study, as do management and design solutions to them and to user conflicts.

    - Monitoring of both the rivers and man-made systems and of the performance of users versus guidelines and standards is needed to provide water managers with information necessary for day-to-day management, as well as to provide important background data for researchers.

- Information exchange among water managers, researchers and users is important for several reasons. It is needed to assist in the safe and effective use of water resources and to provide feedback to managers and researchers on problems experienced by users and on the effectiveness of management techniques. Public information systems must be designed to encourage the exchange of information and ideas to ensure the best use of the water resources of the basin.

Administration and Responsibility

- Administrative policy affecting management should continue to consider the SSRB as a single unit, while ensuring the integrity of the individual streams in respect to maintaining minimum flows during critical water supply periods.

- The Province should continue to be responsible for the development and operation of headworks systems it considers essential to serve viable multi-purpose uses. This is justified in order to manage the supply and to control the instream flows for increasing numbers of water uses; and to ensure that acceptable quality requirements are met.

- As water supply is committed to the optimum level, the licencing and control process will become increasingly complex and will require the appropriate technical and administrative resources to maintain timely and complete accounting and control of water committed across the whole of the basin.

- The very close association of water quantity and quality management should be maintained.

- Interdepartmental and multi-disciplinary considerations of the significant water resource management issues should continue and include a means for communicating information to the public to allay concerns by providing a better understanding of the situations encountered.

- Administrative policy and legislation should assure the authority of the Government and other water management units to vary the "prior allocation" priority system in regard to the amount and continuity of supply during critical water supply periods.

- The maintenance of a strong and resourceful department, with the flexibility to adjust practices as necessary to effectively manage increasingly complex water supply and demand requirements, is essential.

The character of the land, water, and climatic resources of the basin are unique and favourable to intensifying agriculture as a basic economic thrust for that region and Alberta as a whole. The Panel believes that the social and economic aspirations of people in the South Saskatchewan River Basin require effective and sensitive water management.

REPORT DEFINITIONS

The following definitions describe terms and abbreviations used throughout the report.

acre-foot

This, and other imperial measurements found in this report, are used to maintain consistency with the Summary Report, prepared by Alberta Environment, which utilized the imperial measuring system.

An acre-foot is the amount of water required to cover on acre of land to a depth of one foot.

1 acre-foot = 1.2335 dam^3 (1 dam^3 = 1000 cubic meters).

assimilative capacity

The ability of a body of water (usually flowing) to receive and dilute treated waste water to a level that is safe for aquatic life and human contact.

AWRC

Alberta Water Resources Commission

cfs

cubic feet per second
As with acre-foot, such terminology has been used in this report to maintain consistency with the Summary Report.

1 cfs = .028 cms (cubic meters per second).

domestic water use

This term is used, in this report, to refer to the use of water for households, especially at the farm level, as opposed to municipal use, which includes industrial water supplies as well as household.

Ducks Unlimited (DU)

Ducks Unlimited is an international, basically privately funded, organization concerned with maintaining and improving wetland waterfowl habitat.

headworks

As used in the context of this report, `headworks' refers to the portions of the irrigation systems that include on-stream storage facilities, diversions from the mainstem rivers and tributaries, and the conveyance systems to the junctions with the Irrigation Districts' facilities. The Province pays all of the capital and operation and maintenance costs of headworks structures and is in charge of operating them. In the St. Mary Irrigation District this applies to all facilities down to and including Ridge

Reservoir but not including Chin Reservoir. Under the current rehabilitation program the Province, through the Department of Environment, is funding 100% of the rehabilitation or construction costs of some off-stream storage reservoirs under separate agreements with each district. The operation of these off-stream reservoirs will be turned over to each district when construction is complete.

infilling

This term is used to refer to the development of irrigation on lands within reach of the Irrigation Districts' conveyance systems without further extensions beyond that which will be undertaken as part of the rehabilitation program.

instream flow needs

In this report instream flows are considered to be the safe flow amounts required to assimilate wastes, provide water for downstream users and maintain aquatic life and viable fish populations on a continuing basis.

minimum flows

On streams that are regulated or from which controlled diversions are made, minimum flows are the lowest levels to which flows should be permitted to fall in emergency situations during periods of extremely low flows. These flow amounts should only occur for a short duration.

MW

megawatt; 1 megawatt = 1000 kilowatts

off-stream storage

This refers to the diversion of water out of the main channel of a river, usually during periods of above normal flows, through a conveyance system into a controlled storage site, such as artificially enlarged lakes, dammed coulees, etc., away from the main channel of the river.

on-stream storage

This refers to the impoundment of water, by means of a dam, within the channel of the river for later release, as required.

per unit water pricing

As used in this report, the term refers to the concept of consumptive water uses being charged for on a water unit basis rather than on a land unit basis. Water charges or pricing, at this stage, does not reflect a commodity charge for water, but is based on recovering the chargeable portions of treatment, delivery and operational management costs from the users.

PFRA

Prairie Farm Rehabilitation Administration
PFRA is the major federal agricultural water development agency in the prairie provinces.

regulated streams

These are rivers for which the downstream supply can be controlled by means of dams or weirs.

SSRB

South Saskatchewan River Basin
This refers to the entire basin: the Red Deer, Bow and Oldman Rivers and their tributaries (as outlined in Figure 2), including the portion of the system called the South Saskatchewan River occurring in Alberta.

SSRBPP

South Saskatchewan River Basin Planning Program
This refers to the development, by Alberta Environment, of a plan for water management of the entire basin. The Summary Report and Hearings reported on in this document represent one phase in the plan development and implementation.

unregulated streams

These are rivers and creeks for which human activity does not have a significant impact on the flow; i.e. streams which have no dams or major diversions.

upper tributary streams

In this report, these are considered as streams of the scale of the Highwood River, Willow Creek, Mosquito Creek and Beaver Creek, which are tributaries of the mainstem rivers, flowing through agriculturally developed lands, and generally having headwaters in the mountains.

APPENDIX 1

PUBLIC HEARING DATES AND LOCATIONS

Public Hearings regarding the management of water in the South Saskatchewan River Basin were held in the following locations on the dates listed:

Calgary	November 6th, 7th, 1984
High River	November 8th, 1984
Lethbridge	November 13th, 14th, 1984
Taber	November 15th, 1984
Vulcan	November 22nd, 1984
Brooks	November 27th, 1984
Medicine Hat	November 29th, 30th, 1984
Strathmore	December 4th, 1984
Hanna	December 6th, 7th, 1984
Red Deer	December 11th, 12th, 1984

APPENDIX 2

BRIEFS RECEIVED BY ALBERTA WATER RESOURCES COMMISSION

Briefs Presented at the Hearings
(principal presenter in brackets)

CALGARY

November 6th

City of Calgary (Mayor R. Klein)
Trout Unlimited (J. Eisenhauer)
Calgary Chamber of Commerce (A. James)
Alberta Wilderness Association (C. Bradley)
Town of Cochrane (M. Schmitke)
Calgary Hook and Hackle Club (S. Ainslie)
P. Holinshead, Calgary
Sarcee Fish and Game Association (Dr. N. Damgaard)
Dr. D. Thompson, Calgary
R. Harding and J. McLennan, Calgary
G. Burton, DeWinton
Bow Waters Canoe Club (J. Bennett)

November 7th

Canadian Petroleum Association (H. Maciej)
Summer Village of Ghost Lake (Mayor J. Blake)
Dome Petroleum (G. Webster)
Saskatchewan Water Corporation (D. MacLeod)
Sierra Club of Western Canada, Alberta Group (D. Kariel)
Foothills Outdoor Recreation Club (T. Antoniuk & J. Rennie)
W. Milne, Calgary
E. Wolfe, Calgary
Federation of Alberta Naturalists (M. Posey)

HIGH RIVER

November 8th

Town of Nanton (Mayor M. Blades)
High River Chamber of Commerce (E. Couey)
Bow River Protection Society (N. Jennings)
High River Fish and Game Association (K. Bowmaster)
Town of High River (Mayor L. Dougherty)
Town of Okotoks (J. Beat)
J. Paradis, Longview
Village of Cayley (C. Moncrieff)
D. Gardner, Longview
D. Hays, Calgary

LETHBRIDGE

November 13th

F. Nemeth, Picture Butte
Leavitt Irrigation District (D. Sudo)
Town of Cardston (D. Sudo)
R. Francis, Lethbridge
Oldman River Regional Planning Commission (C. Clements)
Village of Nobleford & Village of Barons (read into the record)
Foothills Protective Association (C. Blackburn)
City of Lethbridge (E. Hall)
Lethbridge Chamber of Commerce (P. Harding)
Lethbridge Northern Irrigation District (R. Jensen)
Picture Butte Chamber of Commerce (T. Caruso)
Aetna Irrigation District (Dr. A. Strang)
Lethbridge Fish and Game Association (R. Goodwin)
G. Merrick, Lethbridge
Lethbridge Naturalists Society (T. Dolman)
T. and D. Dolman, Lethbridge
Alberta Sugar Beet Growers Marketing Board (W. Boras)

November 14th

F. Ross, Lethbridge
St. Mary River Irrigation District (P. Langeman)
Blood Tribe - Economic Development Committee (B. Fox)
United Irrigation District (D. Bates)
Mountain View Irrigation District (L. Nelson)
Magrath Irrigation District (G. Dudley)
P. Schuld, Iron Springs
Alberta Soft White Spring Wheat Growers Association (H. Unruh)
Municipal District of Pincher Creek #9 (T. Ferguson)
Town of Picture Butte (P. Ries)
Chinook Country Tourist Association (R. Smith)
P. Wilkinson, Lethbridge
Oldman River Canoe & Kayak Association (G. Ayers)
Dr. S. Rood, Lethbridge
St. Mary River Irrigation District (J. Brewin)
Unifarm - Region #14 (A. Fraser)
Coleman Fish & Game Association (R. Macdonald) (written brief)

TABER

November 15th

Town of Taber (R. Evenson)
Taber Irrigation District (K. Anderson)
Municipal District of Taber #14 (D. Leahy)
Barons-Eureka-Warner Health Unit (K. Blom)
D. Bly, Taber

(November 15th, cont'd)

Alberta Irrigation Projects Association (D. Alberts)
M. Cradduck, Taber
Vauxhall & District Sugar Beet Growers Association (D. Wolosuk)
Foremost & District Chamber of Commerce (C. Hogan)
Bow River Gas Co-op (H. Dick)
Alberta Water Committee (D. Irving)
F. Rabusic, Taber
Town of Vauxhall (B. Howse)
Bow River Irrigation District (J. Friesen)
C. Wallis, Calgary

VULCAN

November 22nd

Village of Carmangay (Mayor G. Massie)
Vulcan Chamber of Commerce (C. Wright)
Clear Lake Committee (G. Roemmele)
Little Bow Water Users (G. Flitten)
Arrowwood Surface Rights Association (R. King)
Willow Creek Irrigators Association (D. Leeds)
Town of Claresholm (Mayor B. Mackin)
Town of Granum (R. Kutt)
J. Dixon, Brant
County of Vulcan #2 (T. Roberts)
G. Logan, Lomond
R. Walker, Champion
Village of Champion (Mayor J. Knight)
A. Jewell, Aldersyde
D. Anderson, Nanton
Town of Vulcan (S. Muntin)
Village of Lomond (Mayor P. Ruppert)

BROOKS

November 27th

Ducks Unlimited (K. Schmitt)
Town of Brooks (B. White)
Eastern Irrigation District Landholders Assoc. (T. Livingstone)
County of Newell #4 (M. Andrews)
Tilley and Rolling Hills Fish & Game Association (J. Desjardins)
Eastern Irrigation District (D. Alberts & H. Campbell)
EID Trapping Association (J. Larsen)
D. Berg, Millicent
Bow River Water Users Association (R. Hiebert)
Bassano Damsite Consumer Committee (S. Raby)
H. Unruh, Vauxhall

(November 27th - cont'd)

L. Peacock, Picture Butte
Brooks & District Fish & Game Association (R. Heppner)
Blackfoot Tribal Council (R. Wright)
Brooks Chamber of Commerce (D. Alberts)
Bassano Chamber of Commerce (B. Plumer)

MEDICINE HAT

November 29th

P. Biemans, Seven Persons
Dr. R. Shaw, Medicine Hat
Improvement District #1 (M.D. of Cypress) (L. Perschon)
Etzikom Coulee Water Users Association (H. Kuehn)
Mayor T. Grimm, Medicine Hat
St. Mary River Irrigation District (J. Brown)
Medicine Hat & District Chamber of Commerce (G. Lehr)
Town of Redcliff (A. Dirkson)
B. Townsend, Medicine Hat
F. Havill, Medicine Hat (read into record)
N. Hogg, Medicine Hat
Bow Island & District Chamber of Commerce (B. Smith)
Village of Foremost (Mayor E. Lynes)

November 30th

Southeast Alberta Regional Planning Commission (A. Dirkson)
City of Medicine Hat (K. Sauer)
Town of Bow Island (Mayor E. Hadlington)
R. Gardner, Medicine Hat
Village of Burdett (Mayor M. Lockie)
L. Peacock, Picture Butte
L. Torrie, Grassy Lake
P. Strickland, Medicine Hat
Unifarm District 133 (E. Gross)
Medicine Hat Economic Development Board (R. Lehr)
Soft White Spring Wheat Growers, District #1 (J. Thacker)
S.E. Branch of the Alberta Institute of Agrologists (D. Cubbon)
B. Hargrave, Walsh

STRATHMORE

December 4th

County of Wheatland (B. Clark)
M. D. of Foothills #31 (Reeve F. Ball)
Town of Canmore (Dr. J. Cheng)
Calgary Regional Planning Commission (Dr. L. Pallesen)

(December 4th, cont'd)

T. Androsoff, Lethbridge
Village of Irricana (Mayor D. Lord)
D. Manz, Calgary
TransAlta Utilities (D. Way & W. Saponja)
Village of Standard (Mayor E. Jensen)
Summer Village of Chestermere Lake (E. Peake)
Town of Staveley (G. Brown)
Western Irrigation District (B. Wyman)
D. Enevoldsen, Standard
Improvement District #8 (R. Slater)

HANNA

December 6th

Village of Rockyford (read into record)
Village of Beiseker (read into record)
Oyen Rural (S. McClellan)
H. Fieldberg, Bindloss
Town of Oyen (Mayor D. Lehman)
Unifarm (S. Bell & R. Buxton)
Alberta Fish & Game Association (H. Fauser)
Dr. A. Laycock, Edmonton
Crossroads 9 & 41 Landholders Association (A. McTavish)
Alberta Irrigation Projects Association (H. Unruh)

December 7th

Special Areas Board and Advisory Council (B. Lockhart)
M.D. of Starland #47 (A. Grenville)
Palliser Regional Planning Commission (Dr. S. Dookie)
Town of Hanna (Mayor S. Dookie)
Empress District (J. Waring)
Prairie Association for Water Management (B. Ashton)
Prairie Farm Rehabilitation Administration (E. Caligiuri)
Cereal & District Development Group (S. Duffield)
Town of Three Hills (read into record)
M.D. of Acadia #34 (Reeve B. McFadyen)

RED DEER

December 11th

D. Campbell, Burdett
P. Biemans, Seven Persons
Red Deer River Naturalists (F. Schutz)
Alberta Research Council (J. Rennick)
Alberta Fish & Game Association (E. Kure)

(December 11th, cont'd)

Alberta Weather Modification Group (H. Howe)
Citizens for Public Justice (G. Nieuwenhuis)
Buffalo Lake Action Committee (J. MacDonald)
Kanata Women's Institute (J. MacDonald)
W. Page, Edmonton (read into record)
County of Stettler Regional Recreation Board (P. Yackulic)
E. Tanis, Picture Butte
St. Mary River Irrigation District (J. Brown)
S. Storm, Rocky Mountain House
M. Kostuch, Rocky Mountain House
Sundre Chamber of Commerce (J. Grimsted)
Trout Unlimited (J. Eisenhauer)
Coronation & District Chamber of Commerce (B. Heidecker)
R. H. Carlyle, Blackfalds (read into record)
Village of Duchess (read into record)

December 12th

Peigan Band (N. Grier)
B. Mitchell, Red Deer (read into record)
Olds College (P. Sproule)
Village of Cremona (C. Haggarty)
Alberta Cattle Commission (J. Grinde)
Red Deer Chamber of Commerce (J. McEwan)
Red Deer Regional Planning Commission (Mayor B. McGhee)
City of Red Deer (Mayor B. McGhee)
Alberta Irrigation Projects Association (D. Alberts)
Lethbridge Northern Irrigation District (R. Jensen)
D. Fawcett, Consort
Calgary Hook and Hackle Club (S. Ainslie)
M.D. of Rocky View (B. Wray)
National Survival Institute (A. New)
Canadian Western Reclamation Ltd. (J. Pearson)
Environment Council of Alberta, Science Advisory Committee (G. Sykes)
Ducks Unlimited (A. Ritter)
Electric Utility Planning Council (P. Roxburgh)
G. Friesen, Lacombe

Written Briefs and Supplements Received

Oldman River Regional Planning Commission -11/01/84
PanCanadian Petroleum Limited - 11/06/84
Village of Cowley - 11/20/84
Milk River Water Users Association - 12/10/84
Alberta Research Council - 12/14/84
Oldman River Regional Recreation Board -12/14/84
Dr. C. Bird - 12/26/84
Town of Ft. Macleod - 01/30/85

A. Russell - 02/09/85
Willow Creek Surface Rights Association - 02/14/85
Alberta Weather Modification co-op - no date
Cowley Fish & Game Association - no date
E. Couey, Cayley - no date
Medicine Hat Fish & Game Association - no date
Village of Nobleford - no date
W. Roth - no date

APPENDIX 3

LOCATIONS OF COPIES OF TRANSCRIPTS

PUBLIC HEARINGS ON WATER MANAGEMENT IN THE SOUTH SASKATCHEWAN RIVER BASIN

Copies of the transcripts from the Public Hearings on Water Management in the SSRB are available to the public at the following locations:

Calgary:

Alberta Environment Library
First floor, Deerfoot Square
2938 - 11th Street N.E.

University of Calgary
Environment/Science/Technology Library
MacKimmie Library
2nd floor, Library Block

Lethbridge:

Lethbridge Public Library
810 - 5th Avenue, South

Lethbridge Community College Library
3000 College Drive, South

University of Lethbridge
Government Documents Section
4401 University Drive
West Lethbridge

Alberta Environment Library
200 - 5th Avenue, South

Medicine Hat:

Medicine Hat Public Library
414 - First Street, S.E.

Planning Commission
Chinook Place
623 - 4th Street, S.E.

Brooks:

Brooks Public Library
201 - First Avenue, West

Hanna:

Hanna Municipal Library
202 - First Avenue West

Red Deer:

Alberta Environment
3rd floor, Provincial Building
4920 - 51st Street

Edmonton:

Alberta Environment Library
14th floor, Oxbridge Place
9820 - 106th Street

Legislature Library
216 Legislature Building

University of Alberta
Science and Technology Library
2nd floor, Cameron Library

Water Resources Commission
#910 Harley Court
10045 - 111th Street

APPENDIX 4

MASTER AGREEMENT ON APPORTIONMENT

The Master Agreement on Apportionment, signed by the three prairie provinces and the federal government, defines the apportionment of the flows of rivers crossing the provincial boundaries. Under the terms of this Agreement, Alberta is permitted to use or store one-half of the total annual natural flow of the rivers arising in Alberta that comprise the South Saskatchewan River system. There are additional clauses which permit Alberta to keep, for its consumptive use, a minimum of 2,100,000 acre-feet annually from the South Saskatchewan River, while requiring that its instantaneous flow at the border does not drop below 1500 cfs. The Agreement is administered by the Prairie Provinces Water Board, which has membership from each of the affected governments.

APPENDIX 5

BASE CASE

The term Base Case, used in this report, was defined in the Summary Report of the South Saskatchewan River Basin Planning Program to describe the water resources situation in the basin when the irrigation system rehabilitation and expansion works committed under the 1980 Water Resources and Irrigation Development program have been completed.

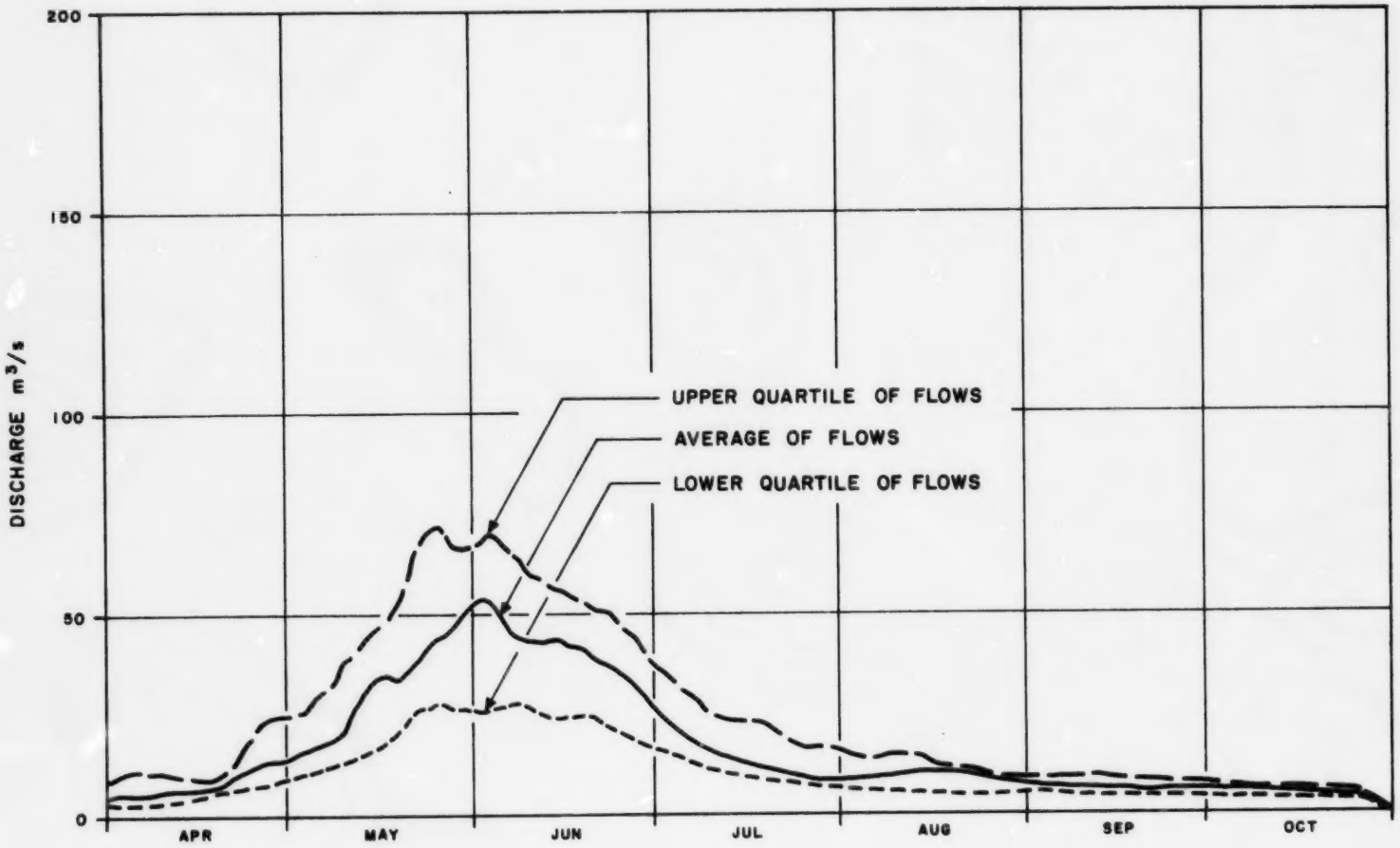
Specifically, the works involved in this program are:

- Oldman River storage reservoir (approximately 400,000 acre-feet);
- rehabilitation of Waterton - St. Mary headworks system;
- rehabilitation and enlargement of the SMRID main canal and development of 70,000 acre-feet of storage at Forty-Mile Coulee;
- enlargement of LNID headworks, including Kehoe Lake;
- rehabilitation and enlargement of Carseland - Bow headworks system;
- rehabilitation and enlargement of the WID headworks canal;
- rehabilitation and enlargement of the EID headworks canal;
- rehabilitation of the Mountain View - Aetna headworks system;
- rehabilitation of the headworks of the United Irrigation District;
- rehabilitation of the headworks of the Ross Creek Irrigation District;
- development of Badger Lake off-stream storage in the BRID;
- development of off-stream storage at Crawling Valley in the EID;
- Sheerness pipeline and Deadfish diversion projects in the Red Deer sub-basin.

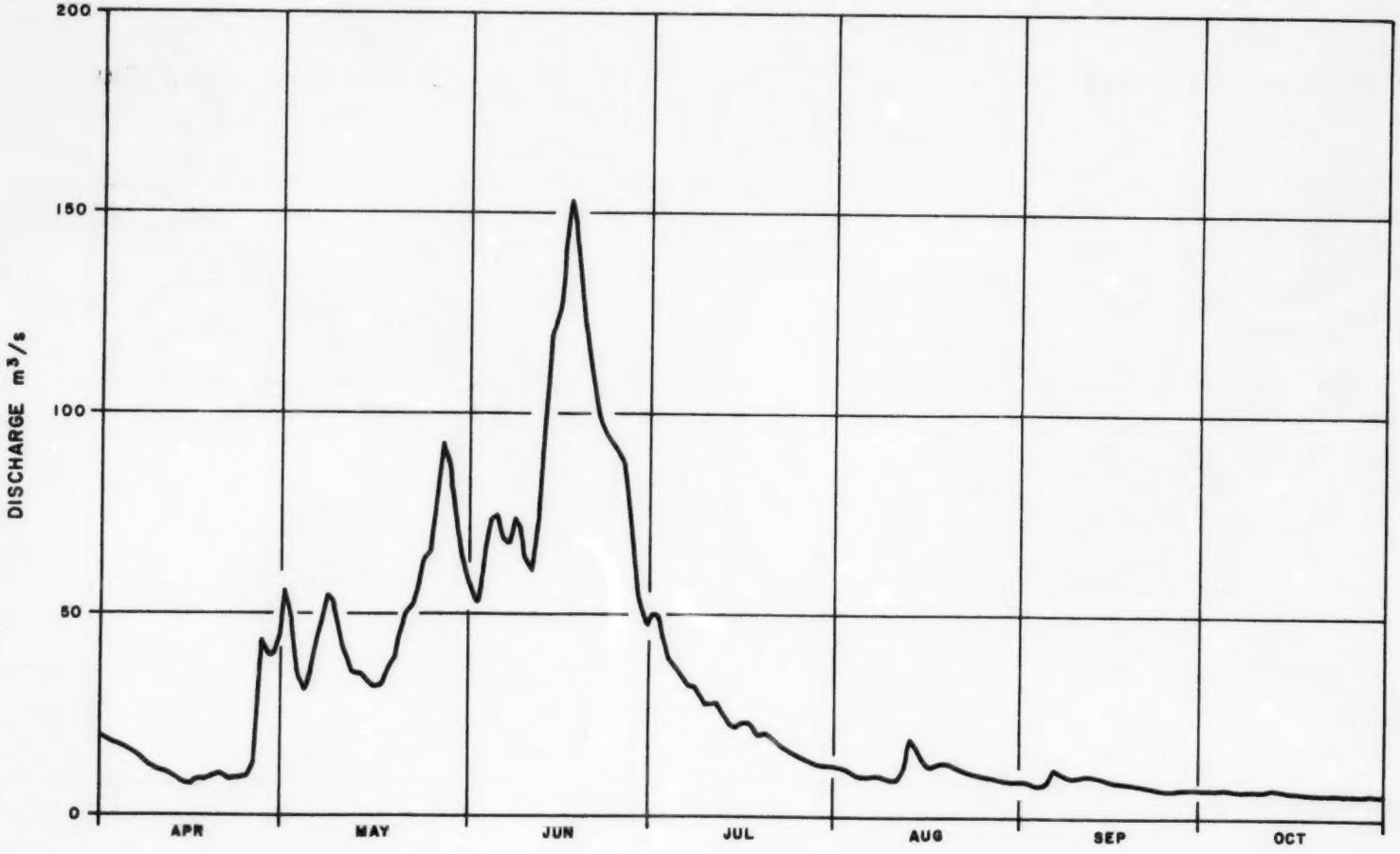
The implementation of these projects, which will be completed by about 1995, will result in a potential for a total of approximately 1,440,000 acres of irrigation, an increase of approximately 400,000 acres over the present level.

APPENDIX 6

EXAMPLE HYDROGRAPHS FOR THE HIGHWOOD RIVER

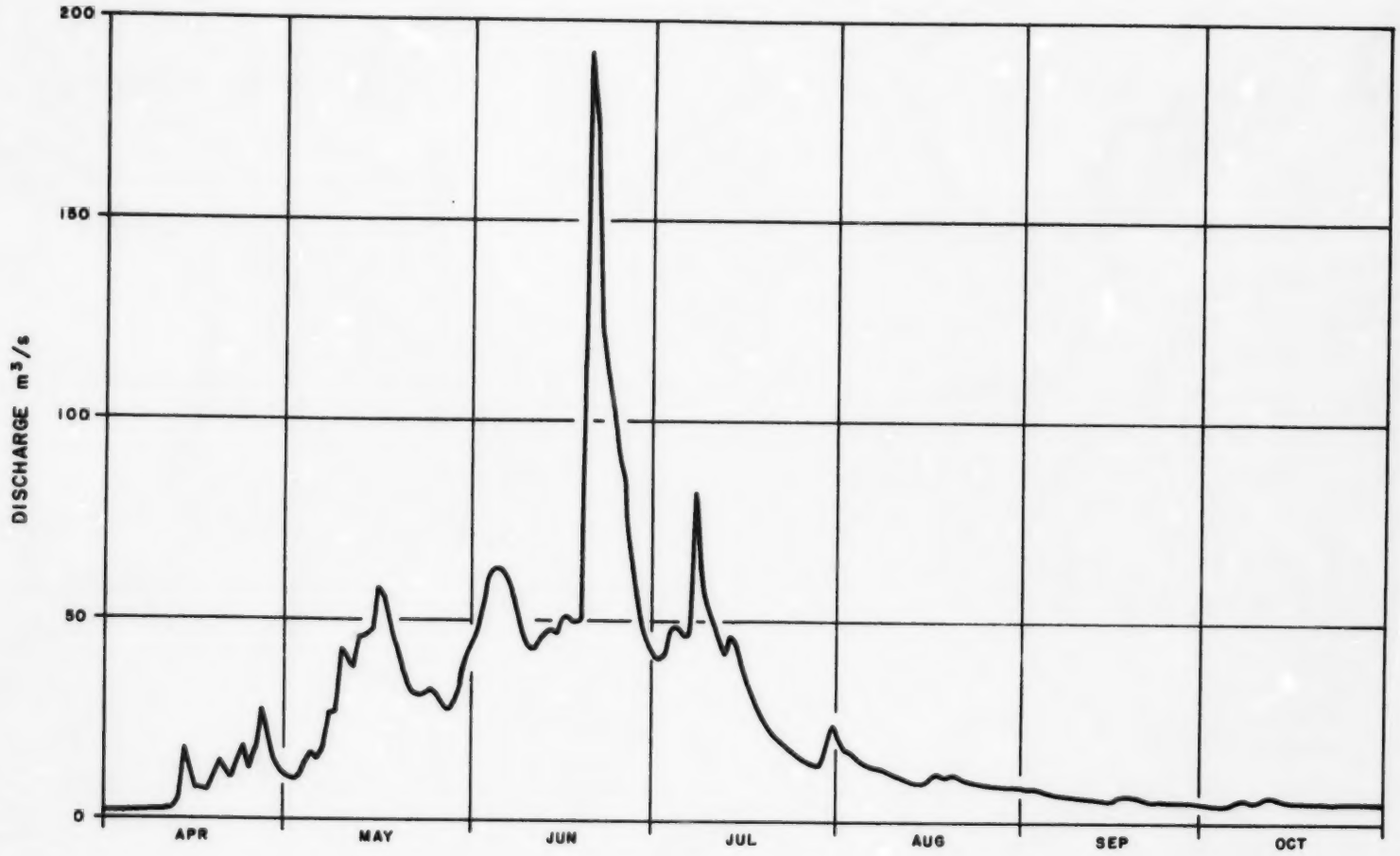


HIGHWOOD RIVER / ALDERSYDE NATURAL



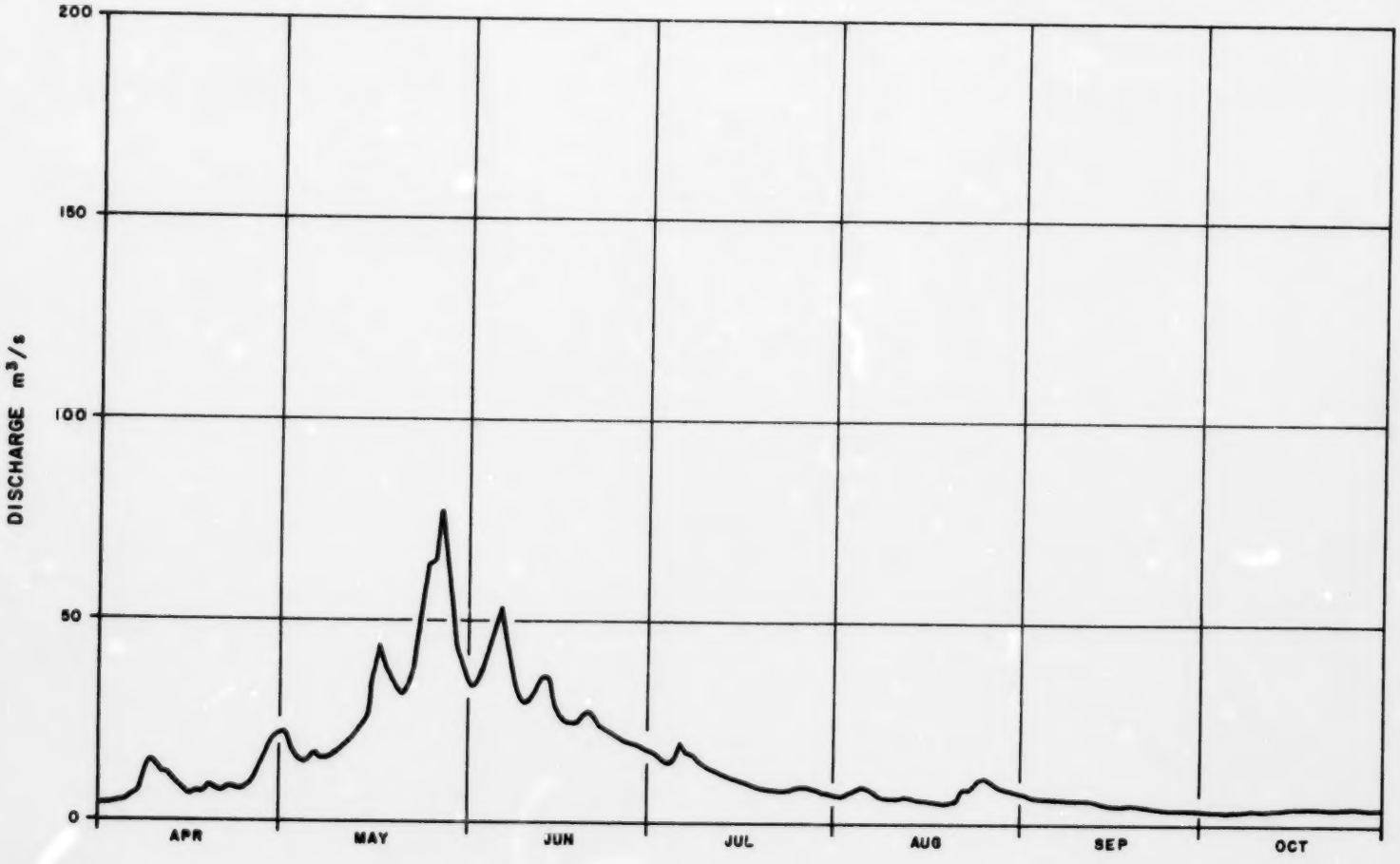
HIGHWOOD RIVER 1974

HIGH SNOWPACK YEAR



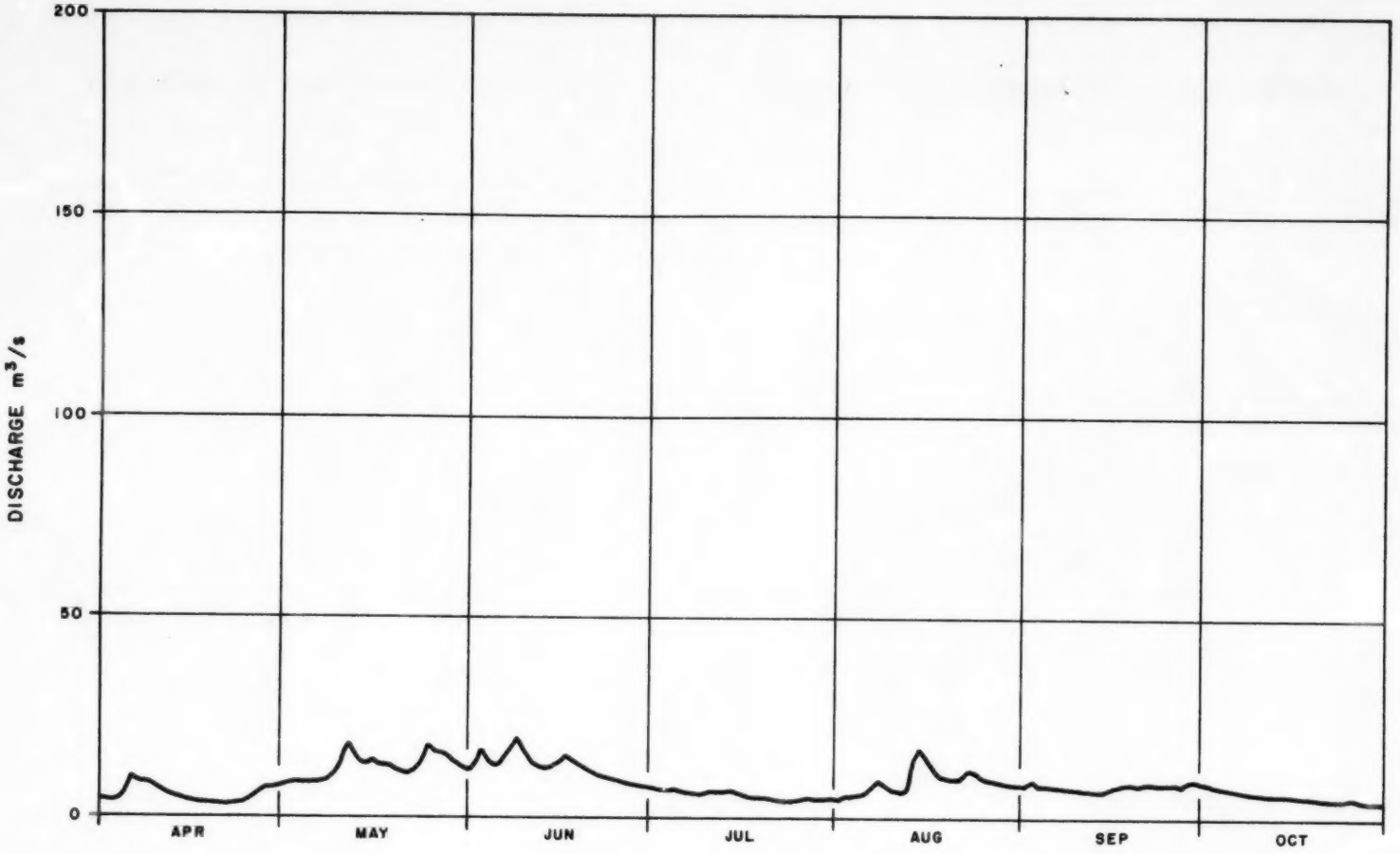
HIGHWOOD RIVER 1975

RAINFALL FLOOD YEAR



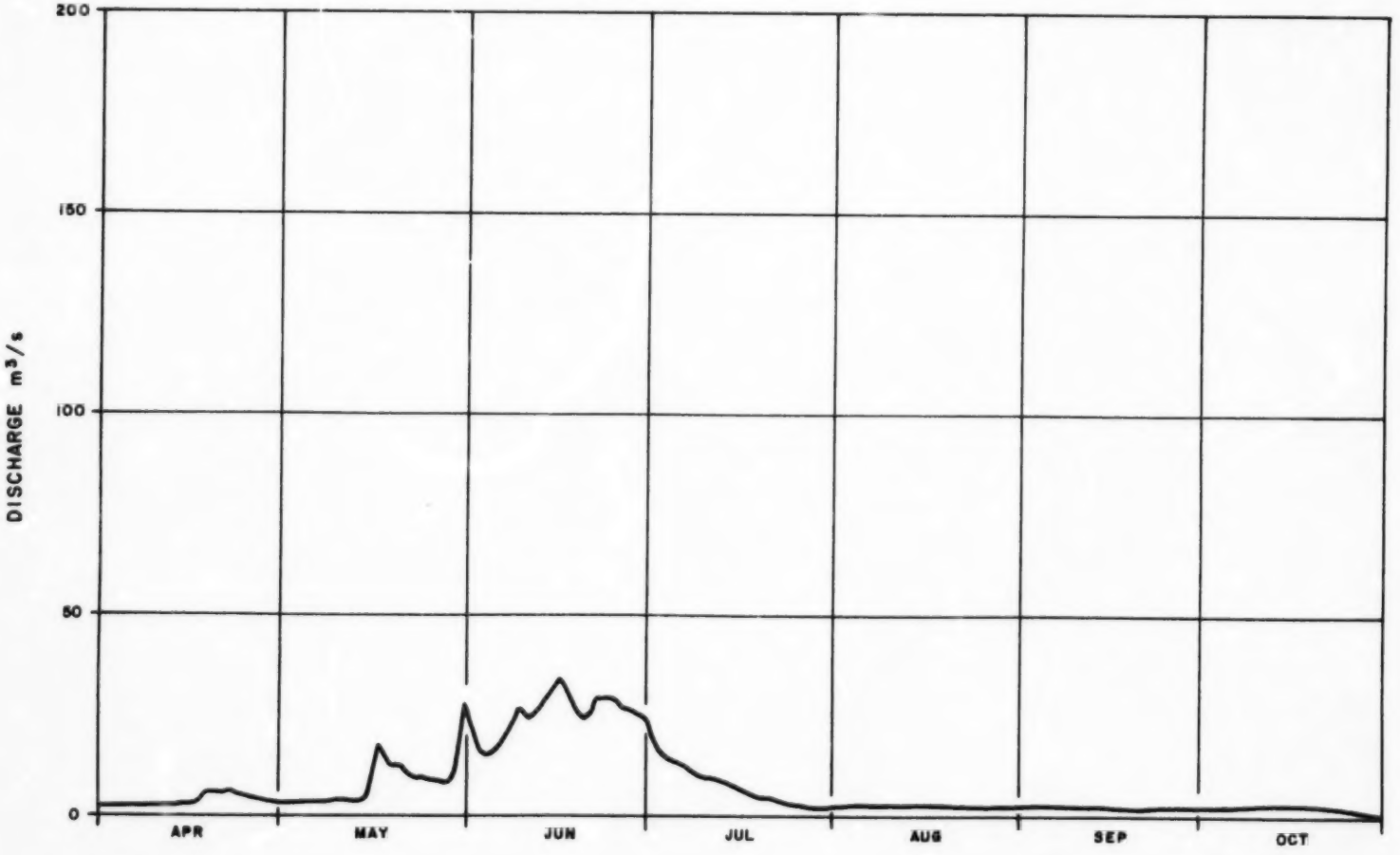
HIGHWOOD RIVER 1979

MODERATE SNOWPACK, DRY SUMMER



HIGHWOOD RIVER 1977

LOW SNOWPACK, DRY SUMMER



HIGHWOOD RIVER 1984

LOW SNOWPACK, DRY SUMMER